A NEW KIND OF TRANSPOSAL SQUARE

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In my article "Single and Double Transposal Squares" in the May 1980 Word Ways, I generalized the concept of word square, allowing one to rearrange the letters in each row and column to form a word. Double transposal squares of size three are ridiculously easy to construct. The one on the left below is perhaps the commonest one, consisting of six words each having more than a thousand occurrences in Kucera and Francis's *Computational Analysis of Present-Day American English* (1967): man 1207, him 2619, its 1858, was 9816, who 2252, not 4609.

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M I H        A I O
A S W        H N S
N T O        T W M
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The letters of a double transposal square of size 3 can be rearranged to form an array with a different set of properties. In the 3-by-3 grid shown at the right, the same six words can be read off in a different way: the letters of each word appear once in each row and once in each column.

This arrangement can be generalized to larger arrays. For instance, in a 4-by-4 array, there are 24 different ways in which one can select sets of four letters, one from each row and one from each column. Can an array be constructed in which all 24 letter sets are rearrangable to words? This can be done; the words from the array below can all be found in the second edition of the unabridged Merriam-Webster:

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Y H B K        cyst  hunt  hind  etch
E S N L        drys  rusk  sick  herd
I A R T        lory  balu  boil  kore
U O C D        lacy  kuan  kino  bade
               Andy  hurl  bids  cake
               tony  bust  lich  bote
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It is obviously impossible to construct a 5-by-5 array with 120 different words out of an array of 25 different letters. To have any hope of success, one must allow letter repetition. But here one must impose an additional restriction in order to avoid trivialities such as arrays consisting of the same 5-letter word repeated five times. The restriction is that no two of the 120 5-letter sets drawn from the rows and columns can be identical. It is a difficult mathematical problem to ascertain all the conditions guaranteeing that duplicates cannot be formed. (One such condition, for example, is that one cannot simultane-

ously place two As in columns a and b of one row, and two Es in columns a and b of a second row.)

Mike Keith programmed a computer to evaluate 5-by-5 arrays, checking which of the 120 5-letter sets in an array could be rearranged to form Merriam-Webster words. Not only did his program check that all letter sets were different, but it also evaluated neighboring arrays (those nearly the same as the original) to see whether a larger number of Websterian words could be found. Using techniques to move to ever-better arrays (climbing toward the summit of a mathematical "hill"), he discovered that one can frequently find arrays with 110 to 115 Websterian words--but a complete Websterian solution appears elusive.

Here are a couple of his best solutions, with 114 and 115 Websterian words, respectively:

E L U R L	R R R R L
E N E L S	A C I M S
A R I T S	A G E T O
A M U S T	A N U S A
A B O D A	A B O D E

12345 anise scree	12354 tined cedar	12435 atune truce
12453 dunes duroc	12534 teton actor	12543 noses scroo
13245 erase girse	13254 deter argid	13425 ureal grume
12452 Druse drugs	13524 lerot morga	13542 roses gross
14235 AEEMT inert	14253 deems nidor	14325 melia EEMNR
14352 deism rends	14523 moles moron	14532 smote snort
15234 tebet ribat	15243 BEESS Boris	15324 blite amber
15342 bessi Serbs	15423 blues rumbo	15432 tubes burst
21345 aisle easer	21354 tiled ardea	21435 Aleut urate
21453 duels douar	21534 lotte aorta	21543 loses roosa
23145 urase gears	23154 trued garad	23415 urare argue
23451 lured dugal	23514 roter agora	23541 loser goals
24135 autem antre	24153 mused adorn	24315 aimer ranee
24351 limed laden	24513 mores aroon	24531 motel talon
25134 butte rabat	25143 buses boars	25314 tribe abear
25341 belis bales	25413 rebus burao	25431 bluet tubal
31245 asale arise	31254 dealt Daira	31425 alula AEMRU
31452 lauds sudra	31524 allot aroma	31542 lasso soars
32145 sauna cares	32154 daunt darac	32415 anura Eruca
32451 dunal ducal	32514 trona caroa	32541 loans coals
34125 amula namer	34152 adsum darns	34215 marae reina
34251 medal ladin	34512 roams arson	34521 molal monal
35124 tubal Abram	35142 ABSSU brass	35214 bater baria
35241 bales bails	35412 bursa bursa	35421 bulla album
41235 alate irate	41253 deals radio	41325 alila ameer
41352 dials reads	41523 salol AMOOR	41532 altos roast
42135 AANTU trace	42153 Sudan cardo	42315 arian ACEER
42351 ladin decal	42513 arson coroa	42531 talon octal
43125 aural gamer	43152 sudra drags	43215 arear regia

43251 alder algid	43512 roars sargo	43521 loral gloam
45123 albus broma	45132 tubas brats	45213 bares baroi
45231 table balti	45312 baris bares	45321 balli amble
51234 AELTT tiara	51243 sales orias	51324 aillt marae
51342 sails arses	51423 sulla amour	51432 talus sutra
52134 taunt carat	52143 Susan Oscar	52314 train areca
52341 snail scale	52413 ANRSU ACORU	52431 altun claut
53124 ultra grama	53142 sarus grass	53214 rater agria
53241 laser sigla	53412 surra sugar	53421 lural algum
54123 mauls manor	54132 tamus rants	54213 mares arion
54231 metal Latin	54312 maris earns	54321 milla leman

Can either word set be completed using words outside of Merriam-Webster? I suggest the following from the Times Index-Gazetteer and the Oxford English Dictionary:

AELTT attle, 'mining rubbish'
ANRSU arsun, var of arson 'saddle-bow'
AEEMT teame, var of 'team' (v2)
BEESS Sebes, Rumania
ABSSU Bussa, Nigeria or Ethiopia
AANTU Nauta, Peru

EEMNR Merne Merna, Australia
AEMRU Col de Maure, France
AMOOR Moora, West Australia
ACEER Cerea, Italy
ACORU Coura, Portugal

In the January 1999 and April 1999 issues of Wordsworth, Ted Clarke discusses a similar problem entitled "Magic Word Squares". There he constructs a 6-by-6 array with all 26 letters of the alphabet represented in the 36 spaces. A complete set of 720 words is, of course, impossible to find; without spending much time on the problem, he located eleven 6-letter words in his array.