VINTAGE PLASTIC SLIDING-LETTER PUZZLES

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One artifact from my childhood in the 1960’s that I still remember vividly is the series of plastic sliding-block puzzles manufactured by The Roalex Company of Forest Hills, NY (no relation to the maker of fine timepieces). These consisted of a high-quality plastic puzzle glued to a piece of cardboard containing information about the puzzle. Most of their sixty or so different designs were based on cartoons or TV shows of the time, such as The Flintstones or The Honeymooners, and typically consist of a single drawing spread over all the tiles, or illustrations of four characters from the show, one in each column. Usually the picture on each tile is different, which means that, just like the Fifteen Puzzle, only half of the possible permutations of the tiles can actually be reached by sliding the tiles.

As a budding logophile, the most interesting Roalex puzzle to me was the one called “Ro-Let” shown in the image to the right. Its design is quite inspired. Not only is the message spelled out by the letters a self-referential advertisement but it is composed from fifteen different letters. Therefore, this puzzle also obeys the parity principle of the Fifteen Puzzle, with only half of the anagrams of its letters being attainable by sliding the tiles. (If a sliding-letter puzzle has even a single pair of identical letters (say, two As) then all anagrams of its letters become possible. The half that would normally be impossible become possible if you simply interchange the two A’s.)

My best friend Jim Tilson and I spent many hours - nay, days and months - playing with the Ro-Let, usually with the goal of finding interesting alternative things for it to say. We filled numerous pages in one of those black-and-white-speckled “composition books” with our creations. In retrospect, most of our efforts were not very good, but some have stood the test of time fairly well:

YAMS GROW BUT HIDE	BUD GOES WITH ARMY
WHAT GUYS BID MORE?	WEB HUGS MIRY TOAD
RUBY SAID, “GET WHOM?”	BUY GAME WITH RODS
MUG WITH BOYS, DEAR	BOY AGES WITH DRUM
GUY’S WORM BIT HEAD	AID THEM...GROW BUSY

One can drop the requirement to be a full sentence, which leads to phrases such as

DEAR BOYS WITH GUM	TWO HUGE ARMY BIDS
GOD WITH BUSY MARE	DAY-TIME GRUB SHOW

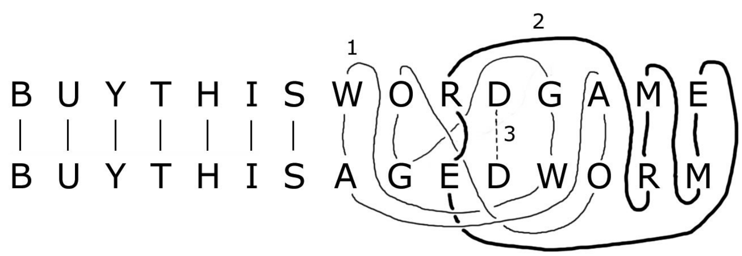
with the last one conjuring visions of an imaginary television cookery program. After much exploration of the 4,4,4,3 form and its permutations we eventually branched out to others, such as 8,4,3 or 7,4,3, where the long word is formed by two adjacent lines of tiles:

WOE, SMUG BIRTHDAY!	BAG DEWY HUMORIST
WIDE HAMBURG TOYS	DUMB WEIGHTY OARS

How can you tell, without actually sliding the tiles, if a given phrase can be formed or not? Here is a simple method. Write BUYTHISWORDGAME and then, below that, the letters of your proposed phrase; we'll use as an example BUY THIS AGED WORM. Then repeat the following procedure until you have visited all the letters in both rows.

1. Pick a letter in the top row that has not been visited yet
2. Draw a line from the letter you're at to the letter below it.
3. Draw a line from the letter you're at to the *same* letter on the top row.
   For instance, if you're at the "A" on the bottom row, continue to the "A" on the top row.
4. Repeat steps 2 and 3 until you arrive back at the letter you started at in step 1.

For this target phrase the end result is the following diagram:



Let p be the number of separate paths in the diagram. In this example there are two long paths (numbered 1 and 2), the degenerate path numbered 3, and seven more degenerate paths using the letters BUYTHIS, for a total of $p = 10$. Let r be the row number of the 4x4 grid that contains the empty space, with the rows numbered 1,2,3,4 from top to bottom. In this example $r = 1$, since the blank space goes with the word BUY. Now for the rule: *a given arrangement of the tiles can be achieved if and only if p+r is an even number*. In this case $p = 10$, $r = 1$, and $p+r = 11$, so it is impossible.

A corollary of the above rule is this well-known fact: starting from a given arrangement in a sliding-block puzzle it is impossible to interchange a single pair of tiles while leaving all the others, and the empty space, fixed. If the empty space does not move then the reachable positions are precisely those in which an even number of pairs of tiles are interchanged.

Before moving on to the next puzzle of this kind, a little story. Once upon a time, in that far-off Analog Age, there was a large printing company. On the upper floors of their building employees could be found setting type for books and the like, but the real action (so some said) occurred in the basement, where the actual pieces of type were manufactured, sorted, and readied for action. When someone upstairs had need of more letters, or a specialized symbol, they would send down a request. The people "down there" were too busy, or too proud, to deign to deliver the requested bits of type in person; instead, a massive system of small elevators in the walls (dumbwaiters) was used to transport the items. Different departments upstairs were served by different dumbwaiters, which came to be known by the kinds of type they generally carried: the Latin Dumbwaiters, Arabic Dumbwaiters, and so forth. Sometimes their names were a bit more whimsical - for example, the ones that carried Greek letters were universally known as the Upsilon Dumbwaiters. But most special of all were the two in the southwest corner of the building, used exclusively for those setting manuscripts in Middle English, who had frequent need for various obsolete characters such as *thorn*, *eth*, *yogh*, or *wyn* (see picture at right). These were, appropriately, called the

þ	*thorn*
ð	*eth*
ʒ	*yogh*
ƿ	*wyn*

YOGH DUMBWAITERS

And so ends our somewhat shaggy story, with an inevitable postscript noting that this phrase is one which can be formed with the Ro-Let tiles. Not only does it contain an 11-letter word, but that word breaks naturally between its three lines (DUMB - WAIT - ERS).

Another manufacturer of sliding-tile puzzles in the 1960's was a Brooklyn, NY company called Plastrix (sometimes written Plas-Trix). Their answer to BUY THIS WORD GAME is shown in the picture here. The top two and bottom two rows of tiles are different colors, which leads to a neat puzzle: slide the tiles so that the colors remain the same and it spells RATE YOUR MIND LAP - a feat that involves swapping just a single pair of letters and so should be impossible. Of course there are two A's in the puzzle, but they cannot be switched since they have different colors. The key is that there are two R's of the *same* color, which can be switched along with L/A to achieve the goal. Because of the duplicate letters it is possible to form any desired anagram by sliding the tiles in this puzzle.

Just like with the Ro-Let, these letters can make many other sentences (RATE OUR MIND PLAY, PART LOUD AIRY MEN, PLAN OUR ARMY DIET, etc.) but since there are a few repeated letters to work with, a harder challenge suggests itself: find an arrangement with a word in every row and column. No such arrangement is possible with BUY THIS WORD GAME using words in Webster's 3rd Unabridged, but a few dozen can be fashioned from RATE YOUR MIND PAL even with the smaller TWL06 North American Scrabble word list. Here are some of them:

	A	P	T
R	U	L	Y
I	R	O	N
M	A	D	E

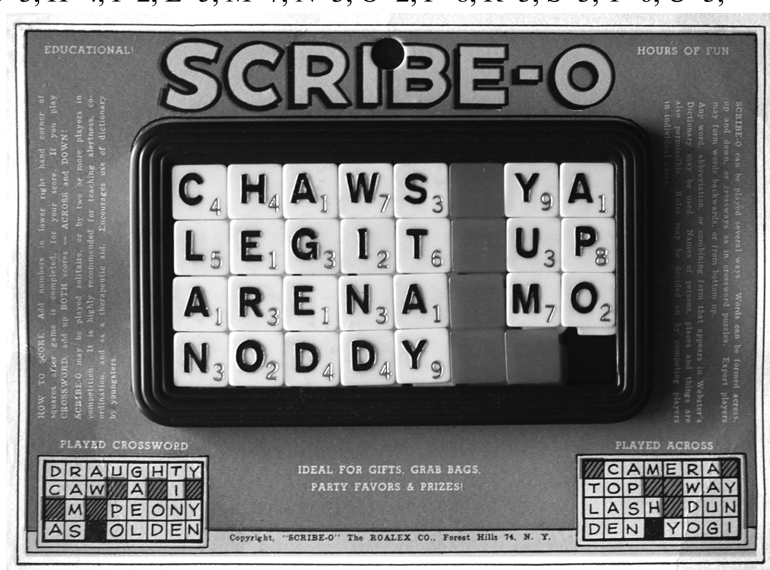
	T	A	U
P	O	R	N
A	M	I	D
R	E	L	Y

	L	I	D
R	A	R	E
A	T	O	M
P	U	N	Y

A	N	T	
L	O	U	D
A	R	M	Y
R	I	P	E

M	I	L	D
U	R	E	A
R	O	P	Y
A	N	T	

A bigger and richer puzzle made by Roalex, called "Scribe-O", is shown in the picture below. It is an 8x4 grid containing 26 letters, 5 blank red-colored tiles, and the empty space. Each letter also has a point value assigned, as follows: A=1, C=4, D=4, E=1, G=3, H=4, I=2, L=5, M=7, N=3, O=2, P=8, R=3, S=3, T=6, U=3, Y=9. I do not know how the tiles were arranged when Scribe-O was originally sold, but my guess is that it was probably just a collection of words like the diagram on the lower right of the card. The design shown in the picture is mine, consisting of 5x4 and a 2x3 rectangles with valid Scrabble words in all the rows and columns.



The instructions on the card suggest two modes of play: (1) Form words in the rows and add up the points for the letters used, and (2) Form words crossword style as in the picture on the lower left of the card, summing the points for the letters in the horizontal words and the letters in the vertical words.

The first game is too easy, as it's a simple matter to find a set of words that uses all the letters, thus achieving the maximum possible score of 97. In fact, it's quite easy to do it with only four words (one per line) and with any possible set of word lengths. Here is an example for each word-length allocation:

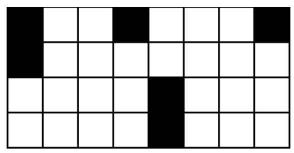
8 8 8 2	MAHOGANY CASUALTY POWDERED IN
8 8 7 3	HOLIDAYS GRADUATE COMPANY NEW
8 8 6 4	SHOUTING COMPARED ANYWAY DEAL
8 8 5 5	PURCHASE DELAYING TODAY WOMAN
8 7 7 4	EMPLOYED AUTHORS DANCING AWAY

8 7 6 5	HARMONIC GATEWAY PLAYED SOUND
8 6 6 6	CHAMPION ARGUED OLDEST ANYWAY
7 7 7 5	TUESDAY HOLDING COMPANY AWARE
7 7 6 6	ANIMALS DOORWAY CHANGE DEPUTY

It's even possible to do it with *three* words, using a 16-letter word spanning two adjacent lines:

16 5 5	NONATMOSPHERICAL GAUDY YAWED
16 6 4	PACHYDERMATOUSLY ANGINA OWED

The crossword mode of play is more interesting. Is the maximum score of 97 x 2 = 194 possible? To achieve this requires every letter to appear in both a horizontal word and a vertical word, which is equivalent to there being, in crossword terminology, no unchecked letters (which, in turn, is equivalent to saying that every horizontal and vertical word has at least two letters). To attack this problem I first determined all possible ways to place the six blanks such that there are no unchecked letters. There are 3764 different ways to do this, and a spot check of a few of them leads to an estimate of a total of tens of thousands of solutions! For example, this configuration of the blank tiles



leads to 1052 solutions all by itself (note: from here on all statements like this apply to the TWL06 Scrabble word list). The huge number of optimal crosswords suggests another question: it is possible to achieve a score of 194 without using any two-letter words (as is required in New York Times puzzles)? Only 52 of the 3764 blanks configurations satisfy this requirement, and it is not too hard to exhaustively search them all for solutions using a computer program. I found a total of 69 solutions of this kind; here are eight of the best:

	P	H	T				
D	O	W	A	G	E	R	S
A	C	A	D	E	M	I	A
Y	O	N		L	U	N	Y

		M	A	W			
A	C	I	D	H	E	A	D
N	O	N	S	U	G	A	R
T	Y	E		P	O	L	Y

				M	I	C	
S	H	O	G	U	N	A	L
P	E	D	A	N	T	R	Y
A	W	A	Y		O	D	E

H	O	N			C	A	W
I	D	E	A	L	O	G	Y
P	A	R	M	E	S	A	N
		D	U	T	Y		

L	A	Y			W	O	G
A	M	A	N	D	I	N	E
C	A	P	T	U	R	E	D
			H	O	Y	S	

P	U	D	S		C	A	W
E	T	I	O	L	O	G	Y
H	A	N	D	Y	M	A	N
				E	A	R	

P	A	N		H	U	T	S
E	G	O	M	A	N	I	A
C	O	W	A	R	D	L	Y
			D	E	Y		

G	U	Y		L	A	W	
A	N	A	T	O	M	Y	
S	C	R	A	P	I	E	
H	O	D	D	E	N		

The last one of these is remarkable since the letter grid fits within a 7x4 sub-rectangle (and is the only grid with words of ≥3 letters to do so). This suggests another puzzle: if two-letter words are allowed, how many grids scoring 194 are there that fit in a 7x4? The answer is 80; a few of the best are shown below. The one on the right is surely one of the most elegant Scribe-O crosswords, as (a) it fits within a 7x4, (b) the 7x4 grid has horizontal symmetry, and (c) it is composed entirely of common words.

Y	U	M		C	A	D	
E	N	O	L	O	G	Y	
P	I	R	A	N	H	A	
S	T	E	W		A	D	

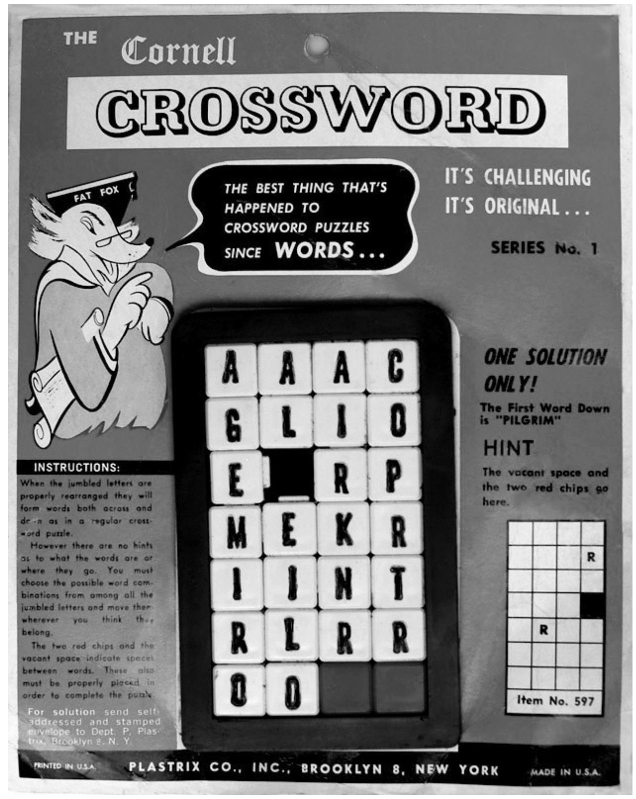
D	A	N	G	L	E	D	
O	C	A	R	I	N	A	
U	H		A	T	O	P	
M	Y		Y	E	W	S	

M	A	G	S		D	O	
A	W	A	Y		O	P	
U	R	I	N	A	T	E	
L	Y	N	C	H	E	D	

U	N	L	A	T	C	H	
R	O	A	D	W	A	Y	
S	O	D		I	M	P	
A	N	Y		G	E	E	

Plastrix made a somewhat similar product called "The Cornell Crossword", shown in the picture here. It consists of 25 letters, two blank tiles, and the empty space in a 4x7 grid. The instructions on the left side of the card are:

When the jumbled letters are properly rearranged they will form words both across and down as in a regular crossword puzzle.
However there are no hints as to what the words are or where they go. [...] The two red chips and the vacant space indicate spaces between words. These also must be properly placed to complete the puzzle.
For solution send self-addressed and stamped envelope to...



This suggests that there should be a single solution ("When the jumbled letters are properly arranged", "For [presumably unique] solution send...", etc.). But on the right side of the card it says:

ONE SOLUTION ONLY!
The first Word Down is PILGRIM

HINT: The vacant space and the two red chips go here.

Does this mean there is only one solution with those extra constraints, or that there is only one solution, period, and it just happens to have PILGRIM in the first column and the three blanks as shown? It's not clear, especially in light of what I discovered when I searched for solutions.

If unchecked letters are allowed (which obviously they are, as the example grid for PILGRIM has three) then there are thousands of solutions if the blanks can be placed anywhere and the first column does not have to spell PILGRIM. There are even 50 solutions with no unchecked letters; here are some of the best:

K	I	L	O
A	G	A	R
■	N	I	L
C	O	R	E
A	R	■	■
R	E	P	O
T	R	I	M

R	O	C	K
I	R	O	N
G	A	L	A
■	■	O	R
L	A	R	■
I	T	E	M
P	E	R	I

G	I	R	O
O	M	E	R
■	P	I	T
R	E	■	■
O	R	C	A
L	I	A	R
L	A	N	K

■	P	O	I
T	I	R	L
R	E	E	L
O	R	■	■
C	O	M	A
A	G	A	R
R	I	N	K

C	A	K	E
A	R	I	L
R	E	■	■
R	O	M	P
O	L	I	O
T	A	R	N
■	R	I	G

A	M	I	R
L	I	T	E
A	R	■	■
R	A	N	G
■	C	O	R
O	L	I	O
P	E	R	K

G	A	R	■
O	M	E	R
R	I	L	E
■	■	A	L
R	O	T	I
I	C	O	N
P	A	R	K

Putting the three blanks in the locations shown on the card, and forcing PILGRIM in the first column, using the TWL06 word list I find...no solutions. Expanding the word list by including all 2-, 3-, and 4-letters from Web3 leads to a handful of solutions - none of them particularly satisfying. Here is the (arguably) best one:

P	A	C	K
I	L	A	■
L	O	R	N
G	E	R	■
R	■	I	O
I	T	E	R
M	O	R	A

This uses five words not in TWL06 but in Web3: ILA (a people and language of northern Rhodesia), GER (a Hebrew-derived word for "foreigner"), IO (interjection), ITER (a Roman road) and ORA (an ancient British currency). Could this really be the intended solution? It seems doubtful. But any solution must have employed some uncommon words or proper names, as there seems to be no arrangement of the tiles using everyday words that fits this particular grid and has PILGRIM in the first column. We leave this as a conundrum for readers to ponder.

Our final sliding-letter puzzle, made by Roalex, was called Lingo, and is rather spectacular in size:

I've never seen an actual Lingo and this is the only picture of one available on the entire Internet. Again, I do not know what the original tile arrangement was but I assume it was a series of short words (what the diagrams at the bottom of the card show, though this picture isn't detailed enough to read the words). Lingo has 45 letters, 11 empty tiles, and the empty space in a 14 x 4 = 56-tile grid.

It's unfortunate that the letter distribution is lousy (only one E, no U's, not enough H's, too many M's, etc), but even so, there's enough to do with a Lingo to keep one busy for a very long time. One obvious challenge is to make just four words from the tiles, one per line:

F	L	A	B	B	E	R	G	A	S	T	I	N	G
P	R	O	C	L	A	M	A	T	I	O	N	S	
M	A	T	C	H	W	O	O	D	S				
P	S	A	L	M	O	D	Y						

H	A	N	D	I	C	R	A	F	T	S	M	A	N
M	Y	S	T	A	G	O	G	I	C	A	L		
B	L	O	O	D	W	O	R	M	S				
S	T	O	P	P	A	B	L	E					

C	A	M	P	A	N	O	L	O	G	I	S	T	S
B	R	O	A	D	S	W	O	R	D	S			
F	L	A	M	B	O	Y	A	N	T				
P	H	L	E	G	M	A	T	I	C				

If we allow more and shorter words then the number of possibilities becomes large enough to suggest a writing challenge reminiscent of those propounded by the Oulipo: write a text in which each successive chunk of 45 letters can be spelled out on the Lingo puzzle, with every word contained wholly within a line. Here is a very short story using this rule:

A pagan cowboy strolls amidst the rambling food camps. From plains he gambols idly past catacombs toward Nog, the domain of symbolic pomp, sallow cats, and braggarts.

A strong woman soberly climbs to a damp, sad cap of light. The two calmly pass, disrobing, as from old pagan combat: bawdy, clasping, a scandal of the top trim. Orgasms bloom.

with the grids for the first three sets shown below.

A		P	A	G	A	N		C	O	W	B	O	Y
S	T	R	O	L	L	S		A	M	I	D	S	T
T	H	E		R	A	M	B	L	I	N	G		
F	O	O	D		C	A	M	P	S				

F	R	O	M		P	L	A	I	N	S		H	E
G	A	M	B	O	L	S		I	D	L	Y		
P	A	S	T		C	A	T	A	C	O	M	B	S
T	O	W	A	R	D		N	O	G				

T	H	E		D	O	M	A	I	N		O	F	
S	Y	M	B	O	L	I	C		P	O	M	P	
S	A	L	L	O	W		C	A	T	S			
A	N	D		B	R	A	G	G	A	R	T	S	

Fashioning a crossword grid with Lingo is a challenging problem even if two-letter words and unchecked letters are allowed, primarily because of the paucity of vowels - the Lingo letter set has just 33% vowels, compared to 40% for Ro-Let and 46% for Scribe-O and "Rate Your Mind Pal", while a typical crossword grid contains 40-45% vowels. Also, the space of all Lingo crosswords is too large to search exhaustively even with a computer, so some shortcuts or heuristics must be employed. My best effort is shown below. All words are in TWL06 and it contains just one unchecked letter and one two-letter word.

T	R	A	C	T	O	R	S				C	A	B
W	I	T	H	A	L		I	F	S		O	B	A
A	L	M	O	N	D		P	O	P	E	D	O	M
S	L	A	N	G	S			G	Y	M			

Can these values (number of unchecked letters, number of two-letter words) be reduced to (1,0) or (0,1) or (0,0)? This question is left as a challenge for the reader.