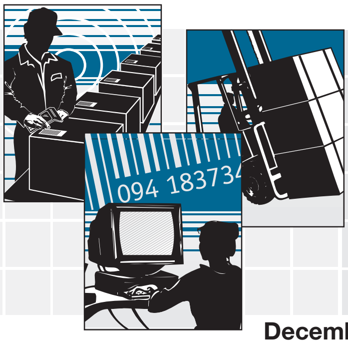


Distribution Center MANAGEMENT

December 2011 Managing people, materials and costs in the warehouse or DC

From the Golden Zone

The classic 15-puzzle: Warehouse slotting logic made simple

by Charles Grissom, Optricity

The 15-puzzle, a sliding tile game, became a craze in the 1880s because it challenges the brain. This classic game also squarely illustrates the subtleties of warehouse slotting.

The 15-puzzle can be used to illustrate the optimal approach to slotting items into a forward pick area of a distribution center, where labor cost is usually greatest and ripe for improvement. The 15-puzzle concepts can also be extended to include slotting of reserve (bulk) storage, and can apply to the broader supply chain network.

4	11	13	12
15	2	14	5
7	6	9	10
3	8	1	

The problem

The basic problem is having items (product) with various characteristics and slots, with the objective of optimally matching items to slots. This scenario is not a simple "Bipartite Matching" problem. In real life, additional considerations, such as physical layout, sequence of slots, and the need to have items allocated under certain rules and constraints — such as velocity or density sequencing, grouping of items to match retail plan-o-grams, order commonality associations, or respecting restriction zones — usually apply.

The rules

The rules help establish an ideal item priority sequence to match against the physical or logical slot sequence (pick path, etc.). Items can then be allocated accordingly, subject to any physical and logical constraints. For this 15-puzzle slotting analogy, let's assume various sequencing rules have been considered such that an ideal item priority sequence and an ideal slot priority sequence are established.

The objective

The 15-puzzle represents a simple version of the problem: We have items (tiles) to be placed into slots (positions on the board) in priority order. Items are numbered from one to 15; slots are numbered one to 15 (left to right, top to bottom).

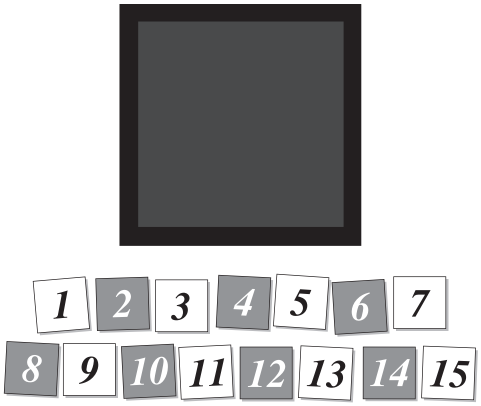
With the goal of matching items to slots, we tackle the puzzle by sliding tiles around, aiming to place tile one into position one, etc. This requires lots of 'moves' (slides) and time.

The slotting analogy

The rules for solving the 15-puzzle involve sliding a tile to the empty space, then sliding another tile to the new empty space. For purposes of slotting, tiles can be removed and replaced, just like items in a warehouse. The analogy to real slotting moves is to pop out one or more items (tiles) and swap positions with other items. The ultimate goal: to get items into the desired sequence.

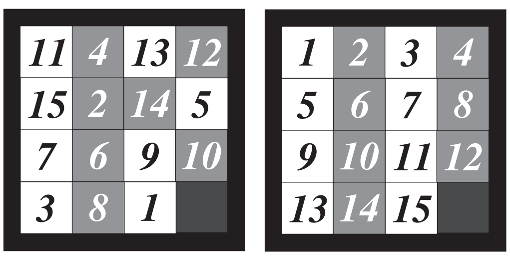
Many slotting systems use this technique to solve the slotting problem because it is easily replicated on the floor and can be shown mathematically to eventually produce the desired solution. The key word is eventually, since it may take a lot of these moves to reach a final solution. With thousands of items and slots, it's often difficult to evaluate progress toward the final solution.

A better method pops all items out of the slots (i.e., tiles off the board), sorts them on the table, and returns them to the correct positions.



The virtual solution

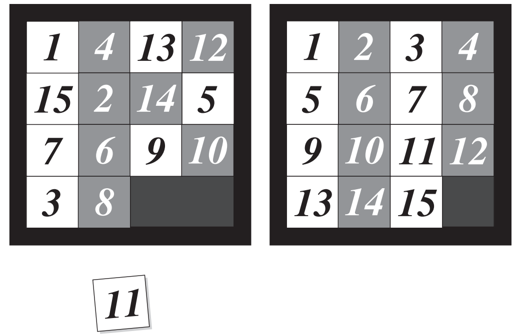
Unfortunately, directly implementing this solution is not practical in the warehouse. But it leads to a new idea: A virtual solution (paper-based, or computer-generated) can serve as a guide to make minimal moves to place items into desired locations.



For the 15-puzzle, place the virtual solution on the right as a guide for performing moves to solve the original puzzle.

Comparing the two puzzles, start at the upper left and remove the first misplaced tile (here, the 11 tile in the one position), and put that on the table temporarily. Then move the one tile into that vacated position.

Notice that tile one vacated position 15, so tile 15 can go there. Continue in this manner. Soon, space 11 will be vacated and tile 11 can go there. It can be shown mathematically that this procedure will produce the optimally minimal sequence of moves. Moreover, to stop at any point in the process (after any move series so there is no tile temporarily on the table) means no item that has moved before is in a less-than-desirable location. Deciding later to resume from this point means no item that has already been touched has to be moved again.



The catch

Using the naive technique previously described by which incremental improvements arise through swapping items around, it might be tempting to swap items 11 and four if they occupy positions one and two as in the original puzzle. Depending on the rules that prioritized the items, you might expect an economic benefit from such a move. But in fact, neither item would be moved to its final location (actually, item four would be moved farther away from its final position), so both would have to be moved again later. Those additional move(s) needed to get items four and 11 into their final locations would dilute any economic effect of the first move.

Further, if items four and three are supposed to be slotted near each other because they are ordered together frequently, the phantom economic benefit of that first swap of items four and 11 evaporates, since item three is still far from item four, even after the swap. Comprehensive cost visibility requires examining the complete solution.

The takeaway

Making incremental moves to improve your slotting can be an expensive waste of time without determining the final solution ahead of time, and using that as a guide for making the right moves.

Chuck Grissom is the chief technology officer of Optricity, a supply chain optimization software provider based in Research Triangle Park, NC. Contact him at info@optricity.com. DCM

Distribution Center Management

712 Main Street — Suite 187B, Boonton, NJ 07005-1450

Telephone: (973) 265-2300 • Fax: (973) 402-6056 • Email: info@DistributionGroup.com • Website: www.DistributionGroup.com

Distribution Center Management™ is published monthly by Alexander Communications Group, Inc., which provides news, data and information on key distribution and warehousing topics though newsletters, books and website.