Jaap's Puzzle Page

Missing Link

This puzzle consists of a square tower of four layers. On the sides are sliding tiles, and each side depicts a chain in different colour. One chain, the white one, is made of only three tiles, so that there is a gap. The tiles can slide up and down into the gap. The top and the bottom layer can rotate so that the pieces from different chains are mixed up.

This puzzle is closely related to the Puzzle Tower/Whip-It and the Ivory Tower/Babylon Tower.

The patent for the Missing Link is US 4,373,729, filed 12 Jan 1981, granted 15 Feb 1983, held by Marvin Glass & Associates. The inventors are Steven P. Hanson and Jeffrey D. Breslow.

If your browser supports JavaScript, then you can play Missing Link by clicking the link below:

JavaScript Missing Link

The number of positions:

There are 15 pieces and a gap, giving a maximum of 16! positions. This limit is not reached because:

- There are three pairs of indistinguishable pieces (2^3)
- The colours are equivalent (4!)

This leaves $16!/(4!\cdot 2^3)$ = 108,972,864,000 positions.

Solution:

The method below solves it column by column. This is not actually the method I generally use, but this was somewhat easier to describe in detail. I solve the Missing Link by moving the pieces into their correct half, top or bottom, and then solving each half separately. This is much quicker than the column method.

Phase 1: Solve one column A column can be solved by sliding the tiles of the chain one by one into the column from the top.

a. Choose the column you want to solve, and which colour chain you want to put there. You must not choose white, but one of the other chains with four tiles.
b. Find the bottom tile of the chain. Manoeuvre it to the second row of the column you are solving.
c. Find one of the middle tiles of the chain. If it lies directly below the previous tile (i.e. third row of the column being solved) then choose the other middle tile instead.
d. Manoeuvre it to the top of the puzzle, without disturbing any previously solved tiles.
e. Move tiles upwards so that the gap is on the third row. Move the tile at the bottom of the column being solved up into the gap, and move down the column, pulling down the middle piece from the top row onto it.
f. Repeat steps c-e for the other middle tile of the column. All but the top tile of the chain has now been solved.
g. Find the top tile of the chain. Manoeuvre it to the top row, and put it at the top of the column.

Phase 2: Solve the second column
A similar method to phase 1 can be used to build the second column. A few changes are necessary because the first column must not be disturbed.

a. Choose the column you want to solve, and which colour chain you want to put there. The column should be next to the previously solved one.
b. Find the bottom tile of the chain. Manoeuvre it to the second row of the column you are solving.
c. Find one of the middle tiles of the chain. If it lies directly below the previous tile (i.e. third row of the column being solved) then choose the other middle tile instead.
d. Manoeuvre it to the second row of the puzzle, with the gap next to it in the second row of the other unsolved column. Do all of this without disturbing any previously solved tiles. Move the tile at the top of the column being solved into the gap, and then put the correct tile in its place at the top of the column being solved.
e. Move tiles upwards so that the gap is on the third row. Move the tile at the bottom of the column being solved up into the gap, and move down the column, pulling down the middle piece from the top row onto it.
f. Repeat steps c-e for the other middle tile of the column. All but the top tile of the chain has now been solved.
g. Find the top tile of the chain. Manoeuvre it to the top row, and put it at the top of the column in the same way as step d.

Phase 3: Solve the remaining two columns.
The last two chains can be solved without sliding any of the tiles in the other two chains. The tiles in the last two chains can move around in a loop, either clockwise (left column up, right column down) or anti-clockwise (right column up, left column down). This loop consists of only 5 tiles; one tile in the top row and one tile in the bottom row can stay in place. Once you are familiar with this, the last chains are not very hard to solve.

a. The steps below will solve the two remaining columns with the white chain in the right column. If you want to have the white chain in the left column then turn the puzzle upside down first.
b. Solve the bottom tile of the left column. This is very easy. From now on this tile will never be moved.
c. Loop the tiles until the white middle tile is in the top row. Leave the tile there, and loop the 5 remaining tiles until the bottom white tile lies in the second row of the right column, and the gap is next to it in the second row of the left column. Now loop the tiles to bring the bottom and middle tiles into position.
d. If the top white tile lies in the third row of the left column, then move the loop clockwise, to bring the tile into the top half. Rearrange the three tiles in the top half, and move the loop anticlockwise, back into position.
e. The top white tile must now lie somewhere in the top half, and the three tiles in the top half can be rearranged to solve the white chain completely, with the gap above it in the right column.
f. If the left column is not yet solved, then loop the tiles clockwise, so that the two middle tiles and the top tile lie in the top half of the puzzle. Rearrange the three tiles so that the top tile lies at the top left, and the gap in the top right. Loop the tiles anti-clockwise, leaving the top tile in place, and the puzzle will be solved.

Note: About the parity problem.

This puzzle has a parity problem just like any other with square sliding tiles. It is impossible to swap two tiles without moving any other tiles to a different position. This puzzle has identical tiles, so two pieces can be swapped if two identical tiles are swapped also. In the solution above the parity problem was not really visible because two identical tiles were solved last. Another way to solve the problem is by turning the top or bottom layers a quarter turn, and re-solve the tiles that were moved. The turn is a 4-cycle, which is an odd permutation, and so this is another way to swap two tiles. This method is also used in the Babylon Tower.

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