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Part 2.1

To adapt the IDA\* algorithm for the modified n-tile problem with wrap-around columns and zero-cost circular row shifts, you would need to:

1. **State Representation**: Update how states are stored and accessed to accommodate wrap-around and circular shifts.
2. **Successor Generation**: Enhance **generate\_successors** to include states from circular row shifts up and down, along with standard moves, accounting for column wrap-arounds.
3. **Heuristic Function**: Modify the **h\_manhattan** heuristic to accurately estimate costs with the new moves, ensuring it doesn't overestimate due to the zero-cost circular shifts.
4. **Cost Function**: Adjust the cost calculation to reflect that shift moves have zero cost.This involves distinguishing between different types of moves and applying the correct cost accordingly.

Part 2.2:

* **Optimize Successor Generation**: Implement checks to prevent redundant state generation and undoing previous moves. This helps reduce the search space and improve efficiency.
* **Enhance Heuristic Function**: Develop a new heuristic that better estimates the distance to the goal with the new moves. This heuristic should closely reflect the true cost of reaching the goal, leveraging the unique movements allowed in this problem variant.
* **Improve Pruning**: Use advanced cycle avoidance to prevent exploring already examined or non-promising paths.
* **Use Memoization**: Store results of expensive computations, like heuristic calculations, for reuse.

Part 2.3:

The puzzle could be designed as a cylindrical device where tiles are arranged around a cylinder's surface. The column wrap-around matches the cylinder's circular nature, and circular shifts mimic rotating the cylinder, shifting all rows. This could be realized with a mechanical device allowing vertical tile movement within segments and whole-segment rotations around the cylinder. This mechanical design would enable both individual tile movements within each row and collective row movements via rotation, possibly with mechanisms to control and limit these movements to ensure only legal moves are made.