27 Designing Facilities to Improve Flexibility: Zone-based Dynamic Facility Layout with Embedded Input/Output Points

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Abstract-- This paper considers solving the unequal area Dynamic Facility Layout Problem (DFLP) using a zone-based structure. Zone-based layouts have significant advantages, such as being easily transferable to a detailed layout with innately included possible aisle structures; therefore, they can be fitted to the unique needs of the layout designers. The unequal area DFLP is modeled and solved using a zone-based structure, which is referred to as ZDFLP, where the dimensions of the departments and material handling system input/output (I/O) points are decision variables. A two-phase matheuristic, which directly operates on Problem ZDFLP without requiring an encoding scheme of the problem, is proposed to solve the ZDFLP with promising results.

INTRODUCTION

A plant producing mechanical products in Shenzhen, China

Motivations

- Manufacturing facilities are frequently redesigned due to changing demands.
- A zone-based block layout structure can be easily transferred to a detailed layout.
- Current DFLP literature does not consider the cost of changing the material handling system over the planning horizon.

SOLUTION APPROACH

A two-phase matheuristic based on Variable Neighborhood Search and MIP (MIP-VNS) where reduced problems are optimally solved.
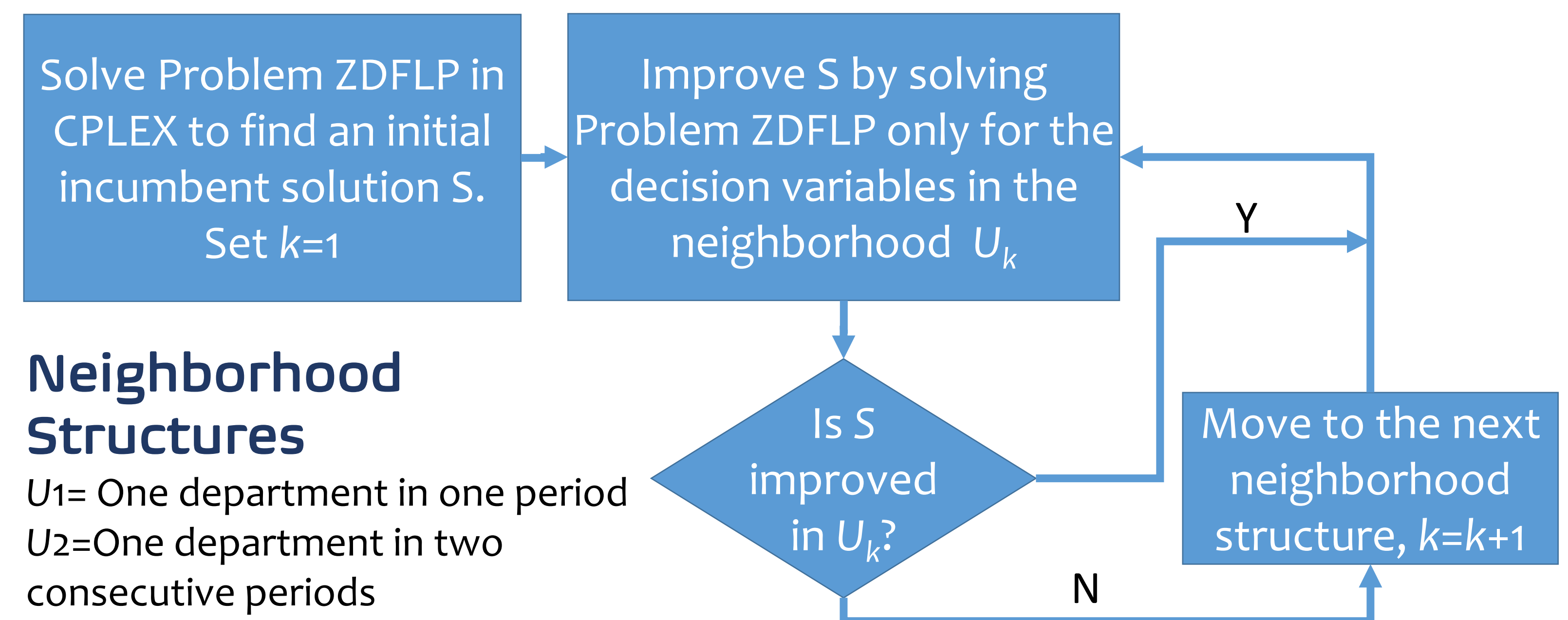

Neighborhood Structures

U_1= One department in one period
U_2=One department in two consecutive periods
U_3= Two departments in one period
U_4=Two departments in two consecutive periods.

MODELING APPROACH

A new mixed-integer programming model of the Problem ZDFLP

- T planning periods, and N_t departments in period t
- The facility is divided into K zones.
- Zone sizes and locations are flexible.
- Departments are arranged either vertically or horizontally in a zone.

Layout t

Layout $t+1$
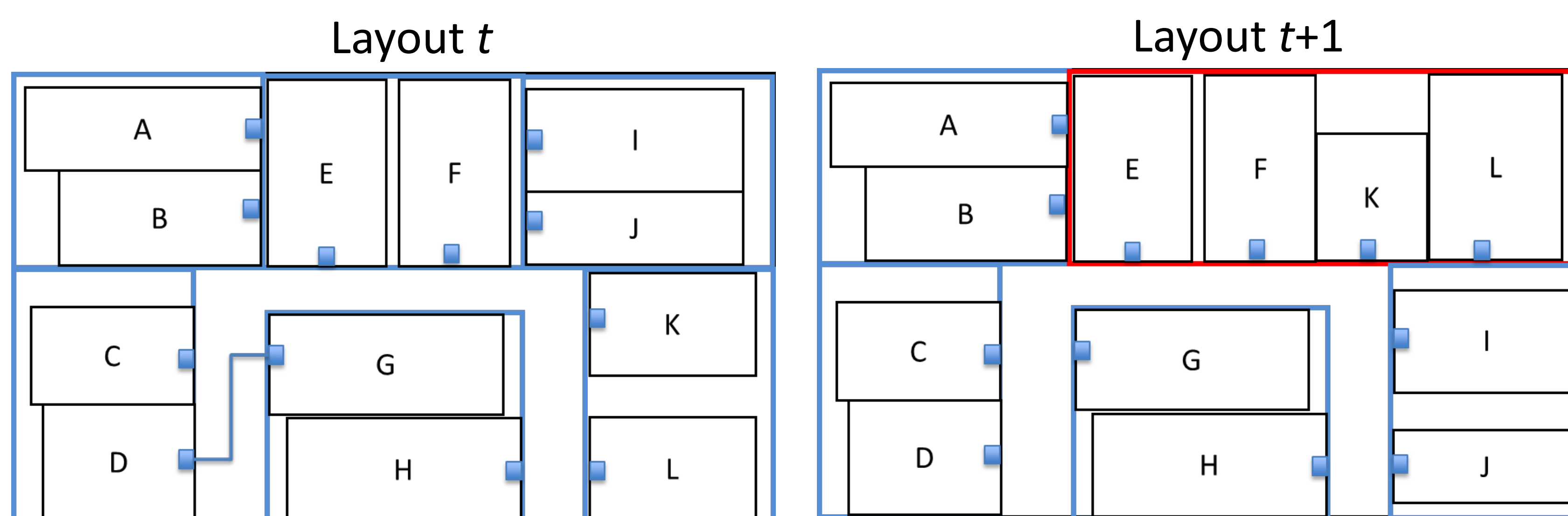
Decision Variables

- Department shapes
- Department locations
- I/O point locations
- Department-to-zone assignments
- Zone locations and boundaries
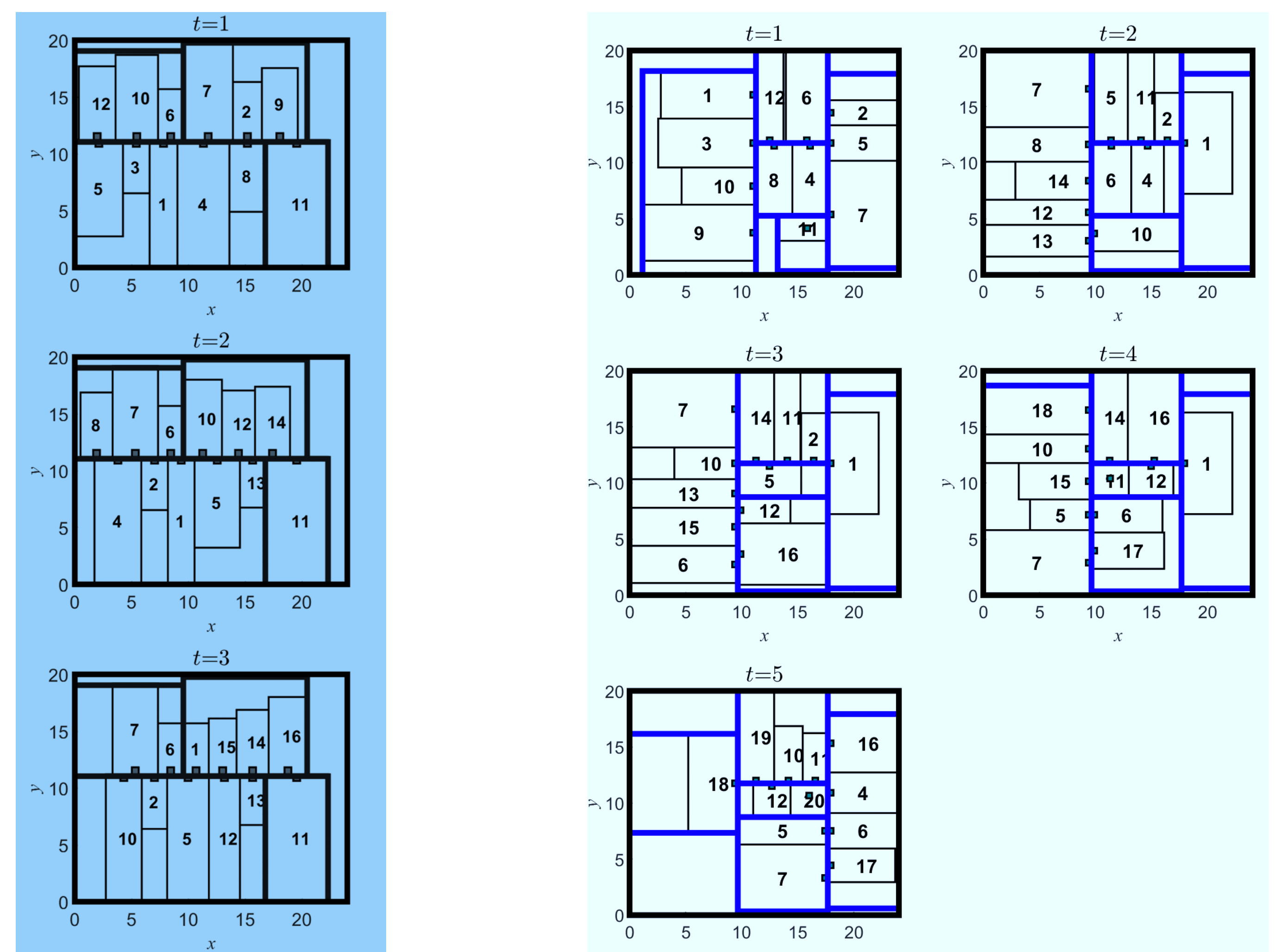- Zone types (vertical or horizontal)

Objective

Minimize (Material Handling Costs + Department Relayout Costs + Zone Boundary Relayout Costs)

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SAMPLE RESULTS

DFLP 12-3b (TC=4,379.77)

DFLP 12-5b (TC=7,474.24)

CONTRIBUTIONS & CONCLUSION

- Unequal area zone-based DFLP with I/O points.
- A DFLP modeling approach closer to real-life applications.
- An easier transfer from the block to the detailed layout.
- Cost of structural changes is included in the relayout costs.
- Matheuristic to solve large problem instances.
- No need for solution encoding.

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