OPTIMAL LAYOUT PLANNING OF SINGLE AND MULTI-STOREYED BUILDINGS

By

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Dedicated to my

Parents

CERTIFICATE

This is to certify that the thesis entitled "OPTIMAL LAYOUT PLANNING OF SINGLE AND MULTI-STOREYED BUILDINGS" being submitted by Miss Rekha Bhowmik to the Indian Institute of Technology, Delhi for the award of degree of Doctor of Philosophy, is a record of bonafide research work carried out by her. She has worked under our guidance and supervision and has fulfilled the requirements for the submission of the thesis which, to our knowledge, has reached the requisite standard.

The results contained in this thesis have not been submitted, in part or full, to any other University or Institute for the award of any degree or diploma.

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ABSTRACT

This thesis deals with the optimal planning of single and multi-level layout problems. Studies have been carried out on all the approaches of layout planning by different authors.

The entire area of activity layout planning is reviewed and is supported by figures. A critical study of the literature available revealed some limitations. There are many algorithms available but they have a very limited applicability. They are restricted to the number of activities and also the number of floors. The objective of this study is to provide architects and layout planners with a solution that can be applicable to all examples of single and multi-level layouts.

The work may be split into three major parts.

(i) Optimal layout planning of single-storeyed buildings

(ii) Optimal layout planning of multi-storeyed buildings using iterative heuristic algorithm involving cluster analysis and branch and bound algorithm

(iii) Optimal layout design of single-storeyed buildings with considerations of building cost, acrhitectural restrictions and communication cost.

For optimal layout planning of single-storey buildings, an iterative heuristic algorithm is employed for the

minimization of total communication cost, while the areas associated with the activities are assumed to remain constant. The procedure is illustrated with the help of four examples. Results corresponding to four different examples have been presented and discussed. Detailed sensitivity analysis has been carried to study the effect of restriction in width on the communication cost and layout. The effect of variation in area on layout and communication cost have also been studied.

The importance and justification for the use of clustering techniques in architectural layout design problems is discussed. Cluster analysis techniques are described in detail and several practical 3-D layout problems are analysed. The problem of arriving at an optimal floor-wise listing of activities i.e. the vertical layout problem is posed from a mathematical point of view. Results obtained from an iterative heuristic algorithm involving cluster analysis and exact solution of the quadratic assignment problem using a branch and bound algorithm are compared. A generalization of the two-dimensional layout algorithm has been tried for the three dimensional layout and the results are compared with both the algorithms i.e. the iterative heuristic algorithm and the branch and bound algorithm.

A non-linear programming approach is used for the minimization of total communication cost to determine the

optimum room dimensions for each activity. The nonlinear programming problem is conveniently solved by the Improved Move Limit Method of Sequential Linear Programming. In this method, the objective function and all the constraints are linearised in the neighbourhood of the design point and an optimum obtained through simplex algorithm. To ensure that the movement is not large, appropriate move-limits are imposed as constraints. The linearization and LP solution are repeated until the exact optimum is located.

The optimal layout design procedure is a two step algorithm wherein a minimum communication cost is obtained and after imposing architectural restrictions, the building cost minimization problem is posed as a mathematical programming excercise involving optimal choice of activity area.

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