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Simulated annealing for manufacturing systems layout design

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SIMULATED ANNEALING FOR MANUFACTURING SYSTEMS LAYOUT DESIGN

(LE RECUIT SIMULÉ POUR L'AGENCEMENT DES SYSTÈMES DE PRODUCTION)

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SUMMARY: In this report, we first present the general Simulated Annealing (SA) algorithm. We then show how it has been used to group resources into manufacturing cells, to design the intra-cell layout, and to place the manufacturing cells on the available shop-floor surface. Some numerical examples are used to illustrate these approaches.

KEY WORDS: Simulated annealing, Manufacturing system layout, Optimization, Cellular manufacturing systems.

RÉSUMÉ: Dans ce rapport, nous présentons l'algorithme du recuit simulé. Nous montrons ensuite comment il a été utilisé (i) pour grouper les ressources en cellules de production, (ii) pour faire l'agencement des ressources à l'intérieur des cellules et enfin (iii) pour placer les cellules sur la surface libre de l'atelier. Quelques exemples illustratifs sont donnés pour chacune de ces applications.

MOTS CLÉS: Recuit similé, Agencement des systèmes de production, optimisation, systèmes cellulaires de production.

1. INTRODUCTION

A new four-stage approach to design an "optimal" layout is presented in this paper. The first stage called pre-processing stage transforms the problem at hand into a mono manufacturing process problem, i.e. a problem in which only one manufacturing process is used to manufacture a part, among alterantives. The main activities performed at the pre-processing stage consists in: (i) allocating the product to the resources (i.e. by sharing out the quantity of each part type to be manufactured among the available resources), and (ii) locating the buffers in the system. This problem is out of the scope of this paper.

The second stage consists of grouping physical facilities into cells in order to minimize the inter-cell traffic, taking into account some constraints[7]. This stage is called Manufacturing cell Design.

The aim of the third stage is to arrange the physical resources inside the cells. This task is performed in two steps. In the first step, an expert system is used to select the material handling system, from which we derive the cell type (several approaches are proposed in references 8, 11 and 6). The second step consists of solving the assignment problems in order to find the best location of each resource (This problem is detailed in the references 9 and 13). This stage is referred to as intra-cell location.

The fourth stage is devoted to the location of cells in the shop-floor in order to minimize the operating cost of the overall system. This operating cost is expressed as the sum of the products (distance between cells x material flow).

Figure 1 summarizes the above strategy. The refinement stage allows the user to modify the manufacturing layout in order to comply with some qualitative criteria.

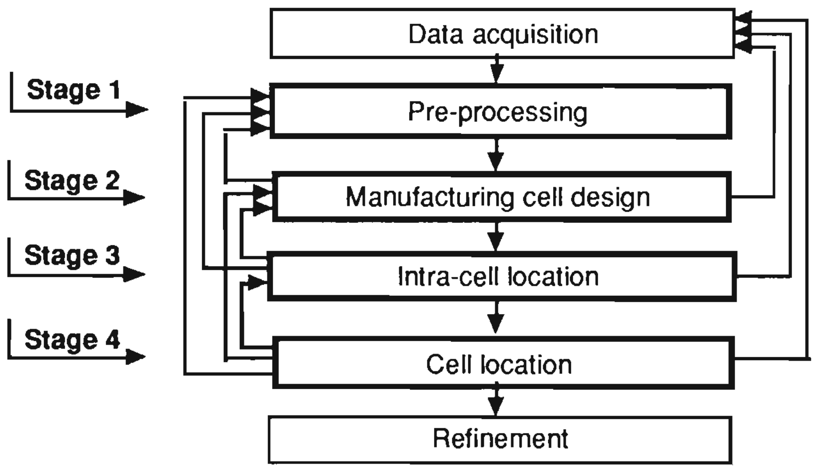

Fig. 1: The strategy for cellular manufacturing system design

The remainder of the paper is organized as follows. Section 2 introduces SA as an approach to solve the combinatorial optimization problems. Cell design, intra-cell layout and inter-cell layout problems are respectively developed in sections 3, 4 and 5. The final section presents some conclusive remarks.