A Fuzzy Genetic Algorithm for the Dynamic Cell Formation Problem*

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ABSTRACT
This paper deals with a fuzzy genetic algorithm applied to a manufacturing cell formation problem. We discuss the importance of taking into account the dynamic aspect of the problem that has been poorly studied in the related literature. Using a multi-periodic planning horizon modeling, two strategies are considered: passive and active. The first strategy consists of maintaining the same composition of machines during the overall planning horizon, while the second allows performing a different composition for each period. When the decision maker wants to choose the most adequate strategy for its environment, there is a need to control the proposed evolutionary solving approach, due to the complexity of the model. For that purpose, we propose an off-line fuzzy logic enhancement. The results, using this enhancement, are better than those obtained using the GA alone.

Categories and Subject Descriptors
G.2.3 [Discrete Mathematics]: Applications; I.2.8 [Artificial Intelligence]: Problem Solving, Control Methods, and Search --- Heuristic methods; J.6 [Computer-aided engineering]: Computer-aided manufacturing (CAM).

General Terms
Algorithms, Design, Economics.

Keywords
Manufacturing Cell Formation, Dynamic Production System, Linguistic Fuzzy Modeling, Genetic Algorithm.

1. INTRODUCTION
Cellular Manufacturing Systems (CMS), an implementation of the Group Technology (GT) concept, consist of dividing the manufacturing system into cells so that similar parts are all produced in the same cell. The success of CMS is rooted in their proven ability to reduce set-up times, in-process inventories, lot sizes and production equipment while improving productivity and facilitating the mastering of the production system.

There are three important steps in CMS design: (1) cell formation, (2) machine layout and (3) cell layout. This paper deals with machine clustering which is one of the main tasks of the first step.

Several works have been proposed for manufacturing cell formation (MCF) problem. However, the majority of these works suppose that part types and their demands are constant during the overall planning horizon. This constraining assumption weakens all approaches trying to solve the related problems. Indeed, the evolution of the production environment, characterized by an important demand disturbance and a merciless market, leads to an adaptation deficiency or even a collapse of the manufacturing system performance. Therefore, to face these risks would require taking into account the dynamic aspect of the production environment. Being informed by the dynamic requirements around the beginning of the nineties, the dynamic aspect of the MCF problem has been tackled by many researchers. In all these works the authors suppose that the number of cells is known *a priori*, and it is also supposed to be static during the overall planning horizon. We can say that a dynamic number of cells can be an important optimizing parameter or even a necessity. Indeed, if all the cells of a plant are saturated in a given period, additional machines will require elevating the number of cells. Furthermore, this restriction gave a considerable help to simplify the reconfiguration cost definition. Nevertheless, this definition must be reformulated when we consider a varying number of cells.

Our paper aims to contribute to these research efforts by proposing an approach that tries to approximate real life circumstances in MCF problem solving by taking into account the dynamic behavior of the input data; by considering realistic constraints and by avoiding restrictive assumptions like static number of cells. We also tried to give a useful help in decision making by considering the decision problem between passive and active strategies. All these issues are addressed in a new approach using a combination of the Genetic Algorithm (GA) and the Fuzzy logic (FL).

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