An improved design for cellular manufacturing system associating scheduling decisions

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ABSTRACT

This paper presents a model for the design of Cellular Manufacturing System (CMS) to evolve simultaneously structural design decisions of Cell Formation (CF) and operational issue decisions of optimal schedule. This integrated decision approach is important for designing a better performing cell. The model allows machine duplication and incorporates cross-flow for scheduling flexibility. The cross-flow is the term introduced to mean the inter-cell movement of parts from parent cell to identical machines in other cells though machines are available in the parent cell. This cross-flow facilitates routing flexibility and paves way for reduced schedule length thereby optimizing resources leading to minimized operational cost. A non-linear integer mathematical programming model is formulated with the objective function of minimizing operating cost which is the sum of Machine Utility Cost (MUC) and inter-cell costs. The MUC is a new cost parameter based on machine utility and it integrates CF, scheduling, and machine duplication decisions. The proposed model belongs to the class of NP-hard problems. A hybrid heuristic (HH) that has "Simulated Annealing Algorithm (SAA) embedded with Genetic Algorithm (GA)" is proposed. A comparison with the mathematical solution reveals that the proposed HH is capable of providing solutions closer to optimal in a computationally efficient manner. The model is validated by studying the effect of integrated decisions, machine duplications, and association of scheduling and cross-flow. The model validation reveals that the proposed CMS model evolves CF, scheduling, and machine duplication decisions with minimum operating cost. Thus, it can be inferred that the proposed model gives optimal integrated decisions for designing an effectively and efficiently performing cells and thus evolves improved CMS design decisions.

KEYWORDS

Simulated annealing algorithm; Genetic algorithm; Scheduling; Cellular manufacturing system; Cell formation.

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