Approximations to Optimal k-unit Cycles for Dual Gripper Robot Cells

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We consider the problem of scheduling operations in bufferless dual-gripper robot cells that produce identical parts. The objective is to find a cyclic sequence of robot moves that minimizes the long-run average time to produce a part or, equivalently, maximizes the throughput.

Our main result is a polynomial-time algorithm that generates a cyclic solution which is a 1.5-approximation to an optimal k-unit cycle ($k \geq 1$) for a practically common subclass of cyclic solutions in cells with dual gripper robots, constant inter-machine travel-time, and the free-pickup criterion. Additionally, we show that this cyclic solution is asymptotically optimal as the number of machines goes to infinity. Over all cyclic solutions, we provide a polynomial-time algorithm which is a 2-approximation. We believe that our structural analysis is an important step toward resolving the longstanding open problem of finding an optimal k-unit cycle ($k \geq 1$) in either a dual gripper or single gripper cell. As a by-product, we provide several managerial insights into the schedules that maximize productivity for dual gripper cells for any combination of processing requirements and physical parameters.