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Total Energy Consumption Optimization via Genetic Algorithm in Flexible Manufacturing Systems

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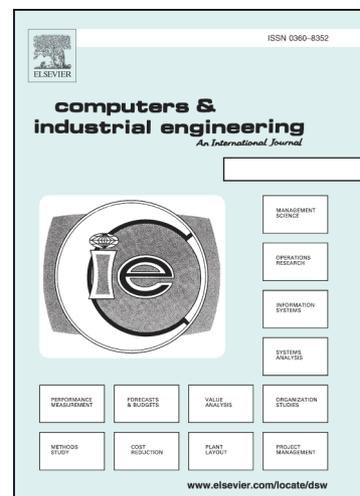
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**Title**

Total Energy Consumption Optimization via Genetic Algorithm in Flexible Manufacturing Systems

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## **Total Energy Consumption Optimization via Genetic Algorithm in Flexible Manufacturing Systems**

**Abstract** – In recent years, there has been growing interest in reducing energy consumption and emissions of manufacturing systems. Except for adopting new equipment or techniques, scheduling is crucial to reduce the total energy consumption of manufacturing systems. This paper focuses on the scheduling problem for flexible manufacturing systems (FMSs) with the objective of minimizing the total energy consumption, and proposes a novel scheduling algorithm for FMSs based on Petri net models and genetic algorithm. Considering that energy consumptions in different states of resources are different, this paper takes two ways for calculating total energy consumptions. In the proposed genetic algorithm, a potential schedule is represented by a chromosome consisting of route selection and operation sequence. Crossover and mutation operations are performed on the operation sequence to guarantee the population diversity. For deadlock-prone FMSs, not all chromosomes can be directly decoded to a feasible schedule. To check the feasibility of chromosomes and convert infeasible chromosomes into feasible ones, a repair algorithm is developed with the help of the deadlock avoidance policy. Experiment results on a typical FMS and an industrial stamping system are provided to show the effectiveness of our proposed scheduling algorithm.

**Index Terms** – Flexible manufacturing system, genetic algorithm, Petri net, total energy consumption optimization, scheduling.

### **1 Introduction**

Energy is the necessary resource for manufacturing systems which can be in various forms such as oil, gas, electricity and etc. In the last 50 years the consumption of energy by the industrial sector has more than doubled and industry currently consumes about half of the world's energy (Mouzon, Yildirim, & Twomey, 2007). The increasing energy prices and requirements to reduce emissions pose new challenge for manufacturing enterprises. Therefore, energy consumption study becomes a more important issue, and has drawn increasing attention in recent years (Giret, Damien, & Vittal, 2015).

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