

## Optimizing CNC Production Line Efficiency Using NSGA-II: Adaptive Layout and Operational Sequence for Enhanced Manufacturing Flexibility

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**Abstract :** In the manufacturing process, computer numerical control (CNC) machining plays a crucial role. CNC enables precise machinery control through computer programs, achieving automation in the production process and significantly enhancing production efficiency. However, traditional CNC production lines often require manual intervention for loading and unloading operations, which limits the production line's operational efficiency and production capacity. Additionally, existing CNC automation systems frequently lack sufficient intelligence and fail to achieve optimal configuration efficiency, resulting in the need for substantial time to reconfigure production lines when producing different products, thereby impacting overall production efficiency. Using the NSGA-II algorithm, we generate production line layout configurations that consider field constraints and select robotic arm specifications from an arm list. This allows us to calculate loading and unloading times for each job order, perform demand allocation, and assign processing sequences. The NSGA-II algorithm is further employed to determine the optimal processing sequence, with the aim of minimizing demand completion time and maximizing average machine utilization. These objectives are used to evaluate the performance of each layout, ultimately determining the optimal layout configuration. By employing this method, it enhance the configuration efficiency of CNC production lines and establish an adaptive capability that allows the production line to respond promptly to changes in demand. This will minimize production losses caused by the need to reconfigure the layout, ensuring that the CNC production line can maintain optimal efficiency even when adjustments are required due to fluctuating demands.

**Keywords :** evolutionary algorithms, multi-objective optimization, pareto optimality, layout optimization, operations sequence

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