Paint Bank Sequence Optimization on Assembly in an Automotive Manufacturing Plant

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Abstract

Automotive assembly plants are tasked with building vehicles which have many different available options. These various options drive different cycle times required to complete the vehicles in final assembly. In the bank between paint and assembly, the cycle time variation required in final assembly makes it advantageous to re-sequence the vehicles leaving the paint shop using scheduling restrictions. The paint bank sequence impact on assembly shop restrictions has been an ongoing issue in the automotive manufacturing industry. Since the sequence fed into the body shop will remain close to the input sequence, the performance of the body shop is considered to be negligible. On the other hand, the paint shop greatly affect's the sequence of vehicles that are fed into final assembly. Specifically, the better a paint shop performs the easier it is to send the optimal vehicle sequence into final assembly. Most vehicle sequence disruptions occur in the paint shop area. This leads to the greatest number of issues in sequencing vehicles-feeding final assembly. These difficulties are what led many companies to utilize the Automatic Storage and Retrieval System (AS/RS) for re-sequencing and sending the optimal vehicle sequence into final assembly. The AS/RS is a large bank between paint and final assembly; it is known as a paint bank. It utilizes a sequencing algorithm that chooses the vehicle order. The performance of the paint bank is measured by the number of violations the sequence has for the final assembly option's constraints.

Vehicle options are scheduled through a gateline sequence which is fed into the body shop based on vehicle orders. This gateline sequence is disrupted as it flows through the paint shop due to many points of mix. It is critical to address the disruption of the sequence for cost and quality impacts on the final assembly shop. In order to address the sequencing problem, a valid simulation model must be created. This research provides methods to create a valid representation of a paint shop in the automotive

manufacturing industry. Based on the validity of the model, continued performance analyses and improvements were conducted.

To address the sequencing problem, a heuristic sequencing algorithm for the paint-to-assembly bank is created. This research provides the following: critical information used in the simulation model, a literature review of the research area, and the results associated with using a heuristic algorithm in the paint-to-assembly bank. In addition to these analyses, the affect on option related violations is investigated through altering the bank configuration.

The configuration of the paint-to-assembly bank was altered from the current 3-lane First-In-First-Out (FIFO) bank to a dual bank 24-lane design. These designs were analyzed through the use of the mean steady state 95% Confidence Interval (CI). This CI was used to measure the current system simulation model Jobs Per Hour (JPH) output to the new system simulation model JPH output using the algorithm. In addition to this calculation, all other models had their 95% CI calculated and a Pair-T test was performed to compare the different paint-to-assembly bank designs. There was a facility constraint with respect to the Chrysler LLC assembly plant. Due to this constraint, it was determined that a single bank 6-lane design utilizing the developed heuristic algorithm was the optimal solution. Had there not been a facility constraint, the single bank 24-lane design, utilizing the developed heuristic algorithm would have yielded the greatest improvement at 56% over the current 3-lane FIFO system. In summary, the single bank 6-lane design utilizing the developed heuristic algorithm provides an improvement of 16%.