Proceedings of the 2025 Winter Simulation Conference
E. Azar, A. Djanatliev, A. Harper, C. Kogler, V. Ramamohan, A. Anagnostou, and S. J. E. Taylor, eds.

PAINT FACILITY SIZING FOR COMMERCIAL AEROSPACE MANUFACTURING

Chris Tonn[1], and Randall Allenbach[2]

[1] Future Factory, Manufacturing Technology Integration, Spirit AeroSystems Inc., Wichita, KS, USA
[2]Technical Fellow – Simulation and Decision Support, Spirit AeroSystems Inc., Wichita, KS, USA

ABSTRACT

Demand for an established paint facility is expected to change significantly due to legacy product phasing out overtime and the introduction of a new product. The new product is physically larger, changing the rate parts can flow through the paint facility. Two primary questions were asked: 1) Can existing paint facilities meet future demand, and if not, when will demand exceed capacity? 2) If new paint booth technology were deployed, how much paint facility will be required? Two discrete event simulation models were developed to answer each question. The current state model played a primary role in identifying that demand would exceed capacity before a new system could be installed and then quantified the impact of implementing a provisional booth. The future state model quantified the resources required in various demand profiles and equipment configurations to ensure proper throughput and process lead-times.

1 INTRODUCTION

Significant demand changes for an existing aerospace paint facility were planned. A legacy product was being phased out and a new, much larger, product was being launched. The new product size reduces the rate at which parts can flow through the paint facility. Two primary questions were asked: 1) Can existing paint facilities meet future demand, and if not, when will demand exceed capacity? 2) If new paint booth technology were deployed, how much paint facility will be required? Due to part flow complexity, schedule overlap, part batch ability, and size constraints two Discrete Event Simulation (DES) models were developed to answer these questions.

2 PAINT FACILITY MODEL DESCRIPTION

Paint facility core processes consist of sanding, washing, masking, painting, oven curing, and demask / inspection. Three aircraft part families are included in these DES models. Each family consists of 20 parts. One of the part families, whose demand is not changing, requires three additional specialized processes: polish, high temp oven, and special coating. These parts are large but batches of two parts are possible if they arrive at the paint facility together, have the same process routing, finish material, and are of the same part family. When batched, the total paint duration is shorter than if two single parts are painted in succession. A one-hour dwell time is allowed at the paint facility arrival buffer to form batches. If no batch is formed, then the parts proceed as a single part. Each part has its own path through the processes. Some parts require multiple loops through the paint process to be considered complete. Each part has a rework likelihood enforced at inspection. If found in need of rework, the entire painting process begins again as a single part. If multiple parts need a specific process at the same time, the most urgent due date takes precedence. After parts pass inspection, they are staged, waiting to be moved into the next process. Special decisions to start parts with respect to how much time remains in a shift were included at the paint booth.

3 CURRENT STATE MODEL RESULTS

The current state system consists of existing equipment and staging areas that are of a specific size and area. Physical part size constrains the current state system at sand, wash, paint, and cure. Legacy part families are smaller, and batches can be utilized in these processes. The new part family is physically larger, limiting some parts to single part-only processing. This puts more pressure on the overall paint system than the legacy part families. A detailed part family demand forecast was used to represent a family's overall production rate and when each individual part is planned to arrive. As the production rate for one of the part families increases or decreases, demand to process all its 20 parts also increases and decreases. The current state model provides feedback on how well it can process the demand. When the system is overwhelmed, parts arrive faster than can be processed, and work in process increases dramatically. By charting work in process over time the point at which the system becomes insufficient for the demand can easily be determined. Multiple scenarios were evaluated including current state equipment, adding mothballed paint booths and ovens, and adding a spoven (paint booth and oven combined in one piece of equipment). Each scenario became overwhelmed at different points of time.

4 FUTURE STATE MODEL RESULTS

The purpose of this future state model is to determine how much of each process is necessary to meet various demand profiles, equipment configurations, and part batch ability. Each scenario applied a year's worth of steady state part family demand to the future state system to identify its effectiveness. Each part is assigned a planned number of flow days. If the modeled flow duration result is less than or equal to the plan then the part was determined to be on time, and if greater it was late. By scoring each individual part performance in the model an aggregate on-time percentage can be calculated. The scenario with the highest on-time percentage would signal a more effective outcome. The objective was to find the most effective scenario with the least amount of equipment. This model assumed equipment would be sized to support batch sizes for any part family thus eliminating size constraints from the model. The timing of parts arriving throughout the day was not known, only the day they are planned to arrive is known and for this reason scenarios were run where batching was maximized or eliminated. Two competing paint equipment philosophies were evaluated: 1) paint booth and oven as separate pieces of equipment with their own footprints or 2) a spoven that can perform both painting and oven activities in the same footprint. Both have technical and quality advantages and disadvantages, but this study focused on the number of resources needed for both methods. This model has three part staging locations: arrival buffer, masking (where parts also stage for a paint booth), and demasking / inspection (where parts also wait to be moved to the next process or shipping). To inform facility engineers when designing a new facility, the model quantified how much space is needed for each of these buffers.

5 CONCLUSIONS

The current state model forecasted when demand would overcome the existing facility's capacity in multiple scenarios including with existing equipment only, adding mothballed equipment, and adding a spoven. This informed production and program leaders the timeframe required to take counter measures and each counter measure's effectiveness. The future state model provided facility engineers tasked with sizing a new paint facility under different equipment configurations. Multiple scenarios of equipment count combinations were tested against varying levels of part family demand, thus identifying which scenario was the most robust at servicing demand. It was identified that the spoven equipment configuration required less overall equipment than the paint booth and oven configuration. This could be valuable if the available square feet for a new paint facility is limited. A matrix of options that met throughput requirements were presented to management and facilities, providing flexibility to fit different options into the available space.