Project Review: HVAC Paint Line Cost Avoidance and Capital Equipment Justification

ProModel
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Client Carrier

Situation

Carrier Refrigeration Operations is a division of Carrier Corporation, and the world's largest refrigeration company. With annual revenues in the billions, Carrier Corporation is the world's largest manufacturer of heating, air conditioning, and refrigeration systems and equipment. It is a subsidiary of United Technologies Corporation, provider of a broad range of high-technology products and support services to the aerospace and building systems industries.

Traditional methods that are used to analyze manufacturing operations consist of optimizing individual elements of the system rather than the entire set of interdependent elements. Subjective evaluation can often be misleading, thus leading to inappropriate use of limited capital funds. We are using ProModel to objectively analyze and predict the behavior of complex systems such as our paint line, which has enabled us to achieve the following goals:

- Productivity improvement
- Cost reduction
- Capital investment justification

This project review focuses on our paint system, which was suffering from several problems:

- Cross contamination during color changes
- Capacity constraints which forces out-sourcing
- Increased cost due to the above

"Simulation has proved to be a necessary, powerful, and cost effective tool for us and will occupy a strategic role in the next millennium, especially within the manufacturing facility. We can now experiment with new processes, equipment, and ideas without affecting daily production."

- Carrier Manufacturing Engineering

Objectives

There were multiple objectives for this project as listed below:

- Build a baseline model of the existing system
- Prove/Disprove subjectively determined capacity constraints
- Determine oven cure capacity and priority
- Identify manpower requirements
- Calculate number of load bars
- Determine washer processing speed
- Explore and prioritize process improvement ideas

Results

The model of the existing system was within 0.2% of actual system performance. "What-if" experimentation then enabled us to determine, with a high of degree of confidence, which process improvement ideas would actually result in meeting our goals. The model was used to select the best among multiple alternative designs by varying system parameters such as speed, process time, capacity, manpower etc. Finally, we used simulation as an evaluation tool to see how well the selected optimal design performed when evaluated against specific criteria. With today's increased global competition and the need for faster response, trial and error experimentation with capital is risky. The animated model was a powerful presentation tool as it enabled us to justify the capital investment, and convince management that the proposed system design changes had been tested, validated and would indeed be most profitable to the company.

Simulation prevented us from making costly errors, thereby saving the company money. One particular idea i.e. improving the washer process rate, would have cost us nearly $500,000, take 8 months to implement, but not yield any improvement. Another idea, would only have cost us $10,000, take 2 months to implement, but still yield no positive results. The following table illustrates the individual cost savings related to not implementing those process improvement ideas that were shown by the model to be not economically feasible.

Solution

Proposed ideas that were not implemented	Cost Avoidance/Savings
Modifying the washer process rate	$ 500,000
Adding an additional paint booth	$ 300,000
Increasing load-bars by nearly 10%	$ 30,000
Changing oven priorities	$ 10,000

"What-if" experimentation enabled us to focus on those areas of the paint system in which we should implement change that would result in the achievement of our goal. The model proven solution of adding an infrared oven, that we are in the process of implementing, will cost us over $500,000, take 8 months to implement, and generate an estimated cost savings of $370,000 annually.

Results

The paint line manufacturing engineer was involved in the entire study in order to build confidence in the validity of the model. The model was constructed using ProModel Simulation, and it was decided beforehand which elements of the system were to be included to achieve the desired goals. In order to replicate the real world system, verify the baseline model, and document our assumptions, we collected real time data during a 5-day span on parts loaded onto the paint line. This data was then used to compare the newly constructed model of the existing paint line with the real world system. Significant hours were spent debugging the model, first in order to verify its authenticity, and secondly in order to convince others of its validity, i.e. the model does truly represent the real paint line.

The model initially enabled us to gain insight into which variables are critical to performance measures such as throughput and cost by analyzing their interaction and effect on system performance. For example, engineering had analytically determined that increasing washer processing speed, cure oven capacity and changing oven priorities would have a positive effect in eliminating current problems. However, the model enabled us to explore the effects of these changes on total system performance. The results yielded no improvement to the existing system, and in certain scenarios were actually detrimental in nature. Animation brought the model to life, and by speeding up and slowing down the simulation, we were able to investigate why certain phenomena occurred, identify existing bottlenecks, and recommend corrective action.

"Change is a daily reality in manufacturing today, and it is simulation modeling that will enable us at Carrier to respond quickly and effectively in order to stay competitive, and exceed our customers' expectations."

- Carrier Manufacturing Engineering