# Increasing the Production Capacity of a Work Cell Using Modeling & Simulation

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A model was developed for a work cell at a specialty wood products manufacturer. The cell uses eight "AE" machines to shape small wood blocks and one "Three-Links" machine to drill, sand, and taper the shaped blocks (See Figure 1).

Two operators load batches of blocks into the AE machines. After shaping, the operators place the pieces into plastic totes and move the totes to rough storage. The Three-Links operator retrieves totes from rough storage and inspects each piece. As demanded by the customer, the operator sorts product into two size classes: wide (pieces above target size) and narrow (pieces below target size).

After sorting, the Three-Links operator loads the Three-Links machine with either wide or narrow product. Following completion of a batch, the operator sets-up the machine for the other size category, loads the other pieces, completes the batch, then sets-up for the next order.

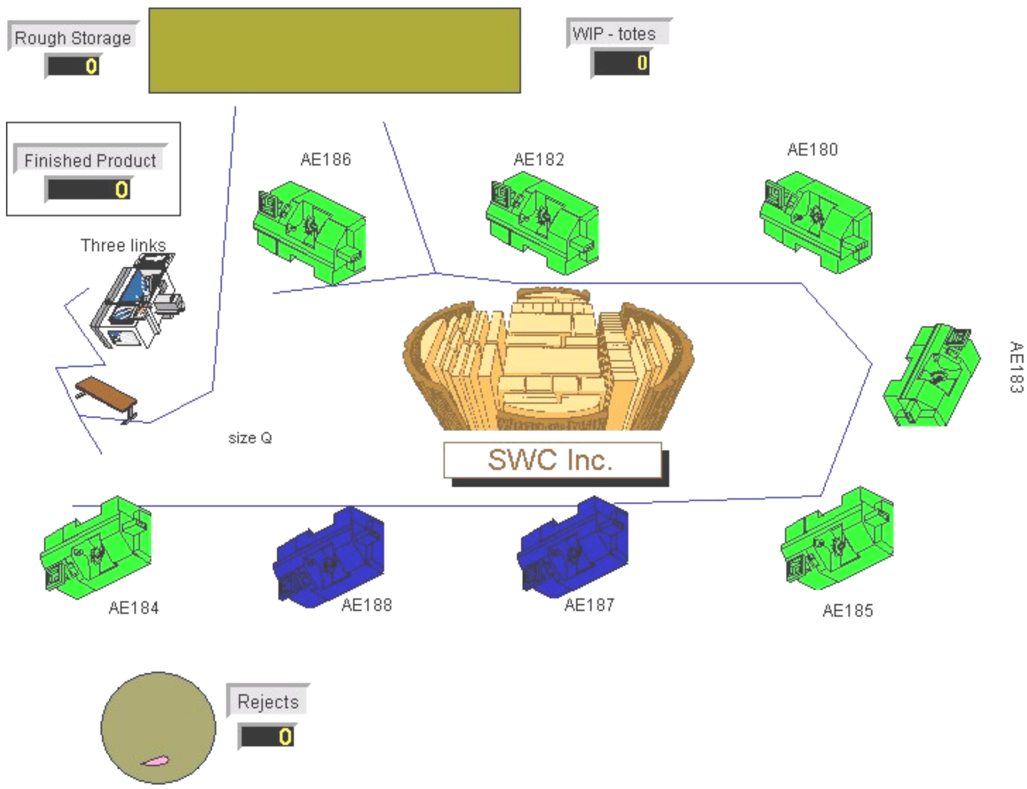


**Figure 1. Layout of AE Cell at SWC Inc.**

*Problem Statement*

The theoretical production capacity for the cell (i.e., no delays due to sorting, scheduling, or other causes of downtime), is approximately 13000 pieces per workday. The actual capacity for the cell has averaged 5000 pieces per day, plus or minus 2000 pieces. Thus, not only is the average capacity unacceptably low but the variation in capacity is excessive as well.

*Project Purpose and Objectives*

The primary purpose for this project was to determine methods to increase capacity for the cell. Specific objectives were to:

- Model the system in its current configuration;
- Use the model to examine the causes of downtime; and
- Explore methods to increase capacity.

The primary performance measures were finished product exits and variation in exits for the work cell.

*Materials and Methods*

Two models were developed for the process. A simple, "theoretical" model was developed to model the flow of the process in a "perfect world"; delays due to sorting and scheduling were not taken into account. A more realistic "as-is" model was then built to account for delays due to sorting and scheduling as well as for varying batch sizes and ratios of wide to narrow product.

Four months' of production data were used to model cycle times for batches (totes). It was assumed that this would account for variations in cycle time for different products lines, setup times, and for downtime.

Each model was run for 100 replications of 1 workday (16 hours).

*Results and Discussion*

The results for product exits were:

| Model | Average Exits | Standard Deviation | Coefficient of Variation | 95% Confidence Interval |
|---|---|---|---|---|
| **Theoretical** | | | | |
| Finished Product | 12346.5 | 579 | 5% | [12231.7, 12461.4] |
| **As-is** | | | | |
| Wide Product | 3268.5 | 650 | 20% | [3139.5, 3397.5] |
| Narrow Product | 2972.6 | 635 | 21% | [2846.5, 3098.7] |
| Total | 6240 | | | |

It is likely that the average capacity for the theoretical model is lower than the expected value of 13000 pieces per day due to the asymmetrical nature of the cycle time distribution for the Three-Links (skewed to longer cycle times).

The average total capacity for the as-is model was significantly higher than currently experienced by the company. This is not surprising in that the as-is model does not account for all the interdependencies and variability that exist in the real system. The primary reason for the output not matching the actual system more closely may be due to the model not explicitly accounting for multiple product lines, breaks, and downtime.

The substantially different values of variation, as represented more clearly by coefficient of variation than standard deviation, show that the as-is model generates both significant reductions in average production capacity as well as increased variation in capacity when compared to the theoretical model.

*Conclusions and Suggestions for Improvement*

Idle time resulting from sorting and scheduling delays is an important factor for low production capacity for this cell as well as for high variability in capacity. Significant increases in capacity can be realized by focusing on increased utilization of the Three-Links machine. Using the ratio of percent utilization to finished product exits resulting from both models, a rough estimate of expected increases is approximately 1200 finished products per day for every 10 percent increase in utilization.

It has been suggested that the company explore requiring the AE operators to sort product (instead of the Three-Links operator) as it exits the AE machines. Totes labeled "wide" and "narrow" would then be placed in rough storage. The Three-Links operator's job would then be to simply retrieve the appropriate tote and load the Three-Links. The delays at the Three-Links should be drastically reduced.

There was insufficient time to model alternatives to increasing capacity. This will be completed at the request of the company in the near future.