# Advanced Simulation

## Homework 2

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Proposed Kanban Cards
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## Description:

The number of Kanbans should be 1 at the Retailer, 4 at Assembly, 3 at Paint, 1 at Fabrication, and 1 at the Raw Material Supplier. This results in 2 total Kanban cards at the Retailer, 8 at Assembly, 6 at Paint, 2 at Fabrication, and 2 at the Raw Material Supplier, due to the use of two card Kanban systems. This is expected to yield a service level of 90% experienced by the costumer, a lead time of 18.5 minutes experienced by the costumer (not including the travel time between retailer and the costumer), and a system lead time of 7.6 hours (including all travel times).

## Analysis Results:

The analysis chosen to determine the number of Kanbans was DOE factorial experiments. The experiments conducted were the following:

- Experiment 1: 5^3 Factorial – Levels {5, 15, 30} – Replications: 30
- Experiment 2: 5^3 Factorial – Levels {2, 19, 40} – Replications: 30
- Experiment 3: 5^3 Factorial – Levels {1, 3, 7} – Replications: 30
- Experiment 4: 5^5 Factorial – Levels {1, 2, 3, 4, 5} – Replications: 1
- Experiment 5: Top 100 Scenarios based on System Lead time from Experiment 4 – Replications: 30

These DOE experiments allowed variety of Kanban combinations to be evaluated in five parts to speed up the process of finding a good set of levels and combinations to choose from. Kanban combinations were valued based on three key metrics: Retailer lead time, Retailer service level, and System lead time. These were chosen because the two Retailer metrics quantify what is experienced by the costumer, and the System metric quantifies total lead time, which is meant to be minimized in lean systems. After Experiment 3, the data showed that the better Kanban combinations were smaller values between 1 and 5, which lead to the need for more levels. Experiment 4 was run with one replication to quickly capture point estimates of the better combinations out of the 5^5 combinations. The top 100 combinations from Experiment 4 were chosen based on lowest System lead time and then run for 30 replications in Experiment 5 to better quantify their Retailer lead time, Retailer service level, and System lead time performances.

The final 100 combinations were given a rank (ie. an integer value between 1 and 100) for each of the three key metrics. The larger the rank indicates the better the value of that metric relative to the other combinations. The largest average rank across these three ranks yielded the scenario explained above in the Description. A final rank calculation was chosen as the way to pick my system because I was indifferent to the three key metrics and wanted to balance these three metrics.

## Model Notes:

- The entire system starts wet according to the number of kanbans for each location, therefore there is no warmup period.
- The runtime is 24 hours, 3 days of work, to allow for more Kanban combinations and replications to be evaluated quicker.
- The total number of Kanban combinations evaluated were 3854.

- The model starts at the source Costumer_Order, which can be found below the Retailer's production system. When the order reaches the sink Costumer_Order_Accepted, this triggers the release of a finished good at the separator SatisfyDemand_Consumer. The resulting withdrawal Kanban card moves upstream triggering the replenishment of finished goods. Once a production Kanban card moves upstream to Production_Retail, this triggers the retailers processing time as well as an order for more product from Assembly. The retailer's order can be found below Assembly's production system, and this pattern of pull continues upstream.