IE251 Spring 2024

Tecnomatix Plant Simulation

Session No. 2

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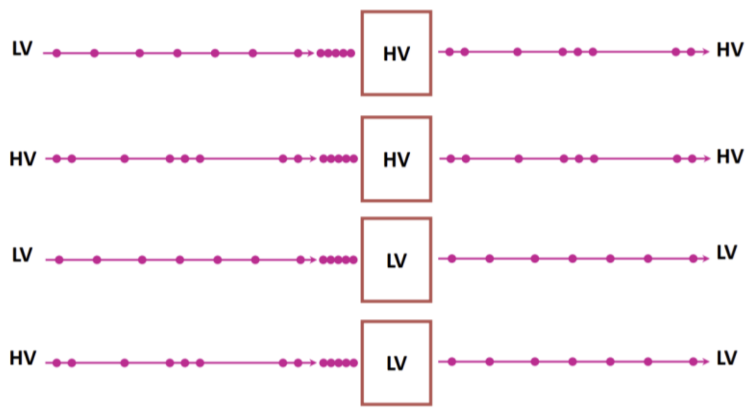
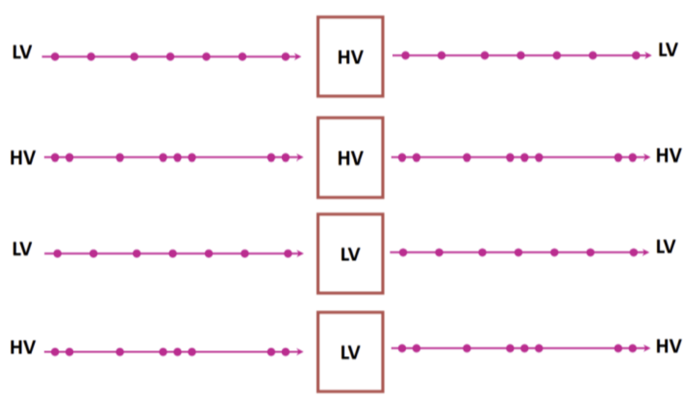
Task 3 - Propagation of Variability

High Utilization Station



Conclusion: flow variability out of a high utilization station is determined primarily by process variability at that station.

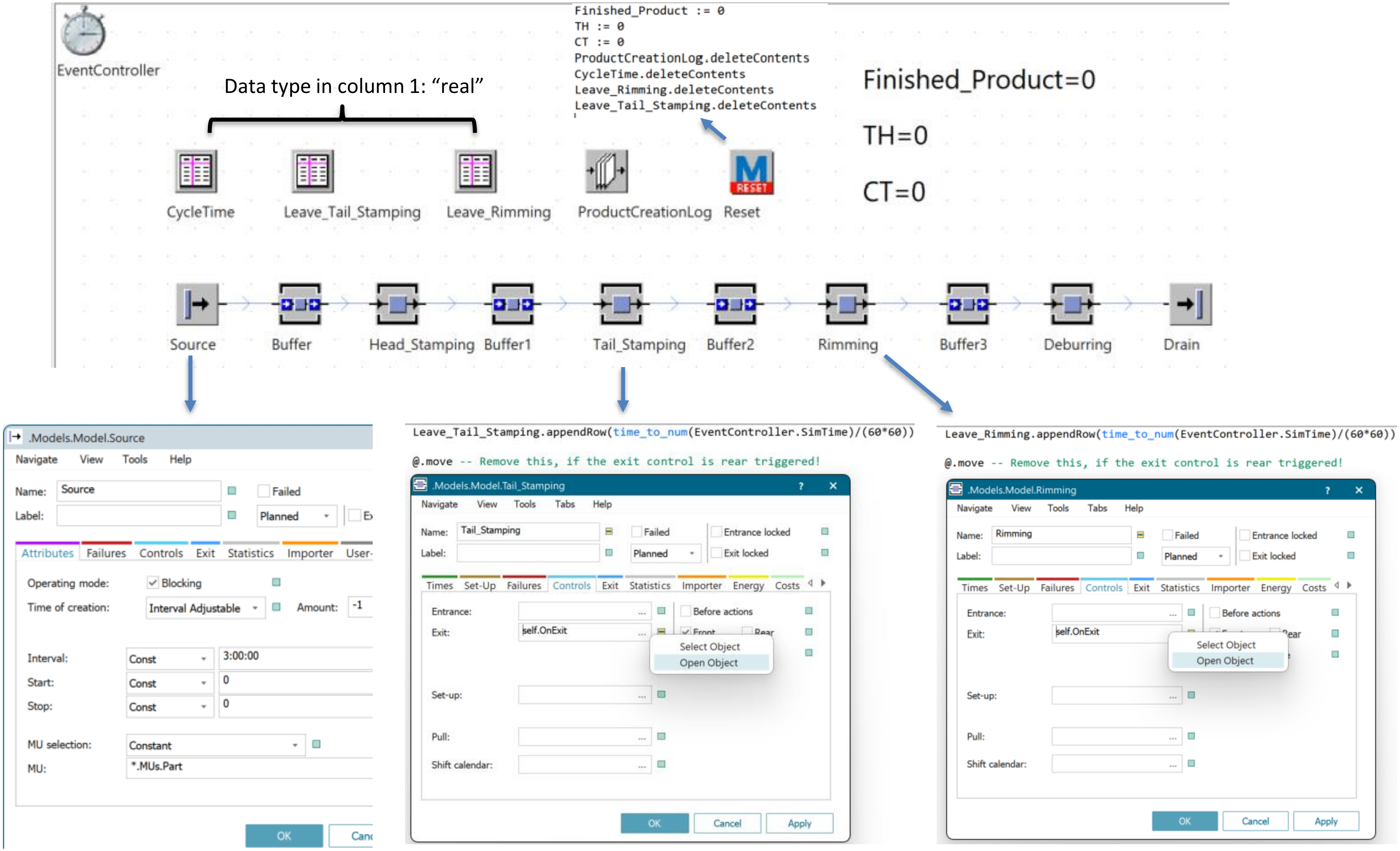
Propagation of Variability – Low Utilization Station



Conclusion: flow variability out of a low utilization station is determined primarily by flow variability into that station.

- We create a production line that reflects the scenarios described on the lecture slides
- Does the simulation confirm the lecture slides? If deviations exist, why is that so?

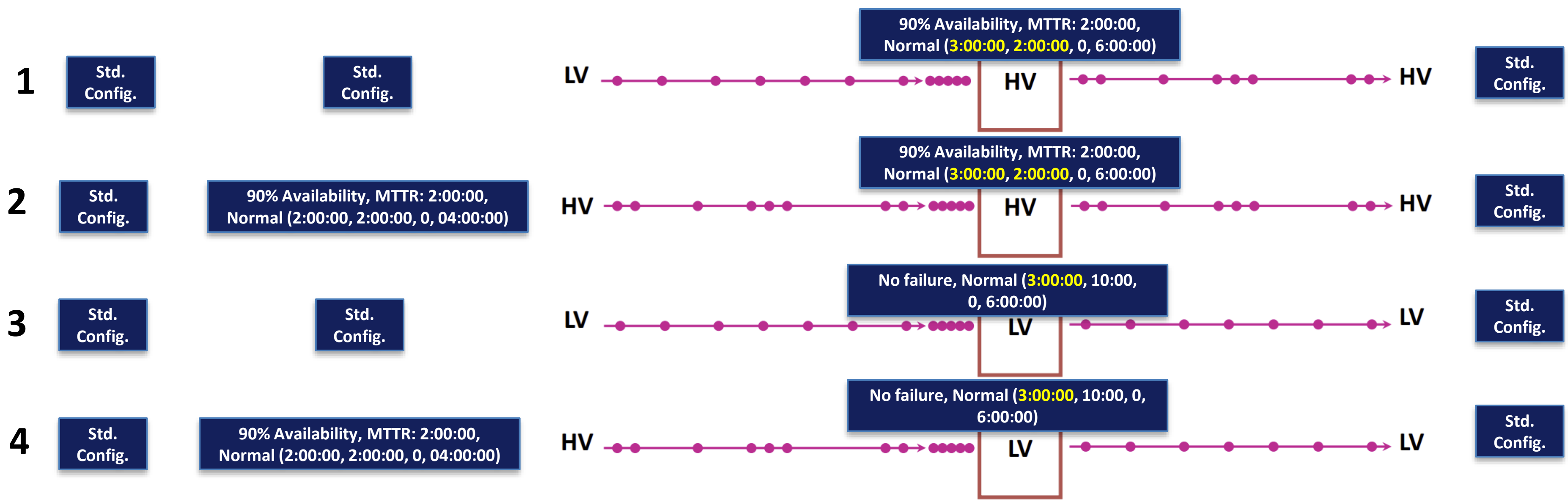
Task 3 - Propagation of Variability



Task 3 - Propagation of Variability

Head Stamping | Tail Stamping | Rimming | Deburring

Propagation of Variability – High Utilization Station



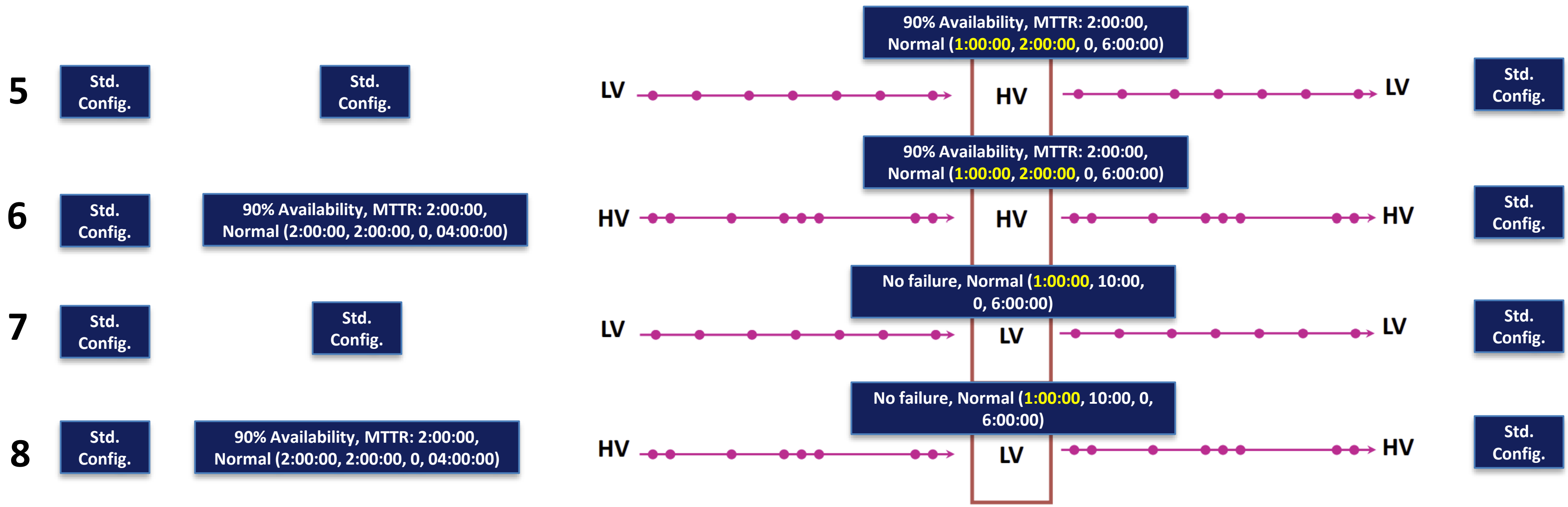
Conclusion: flow variability out of a high utilization station is determined primarily by process variability at that station.

Std. Config. = No fail & Normal(2:00:00, 10:00, 0, 4:00:00)

Task 3 - Propagation of Variability

Head Stamping | Tail Stamping | Rimming | Deburring

Propagation of Variability – Low Utilization Station



Conclusion: flow variability out of a low utilization station is determined primarily by flow variability into that station.

Task 3 - Propagation of Variability - Processing the Results

$$t_a = \text{mean time between arrivals}$$

$$r_a = \frac{1}{t_a} = \text{arrival rate}$$

$$\sigma_a = \text{standard deviation of time between arrivals}$$

$$c_a = \frac{\sigma_a}{t_a} = \text{coefficient of variation of interarrival times}$$

```
input_data = """

"""

import numpy as np

# Convert input data to a list of floats
data = list(map(float, input_data.strip().split()))
# Calculating deltas between the floats
deltas = np.diff(data)

average_data = np.mean(deltas)
print("Avg. time between departures:", average_data)
std_deviation_deltas = np.std(deltas, ddof=1) # ddof=1 for std deviation
print("Avg. STD:", std_deviation_deltas)
coeff_of_variation = std_deviation_deltas/average_data
print("Coefficient of variation", coeff_of_variation)
```

Task 4 - Hare X19 vs. Tortoise 2000

There are two similar workstations. Both the Hare X19 and the Tortoise 2000 are composed of a single machine. Both machines have a process time mean of t_0=15 minutes and processing times follow exponential distribution. Jobs arrive at a constant rate of 20 minutes per job in both cases. These two workstations maintain a WIP level of 5. The Hare X19 has long but infrequent outages, while the Tortoise 2000 has short, frequents ones. The Hare X19 has a mean time to failure of 744 minutes, and a mean time to repair of 248 minutes. The Tortoise 2000 has an MTTF of 114.0 minutes, and MTTR of 38.0 minutes. Assume that the arrival time, MTTF, and MTTR are deterministic.

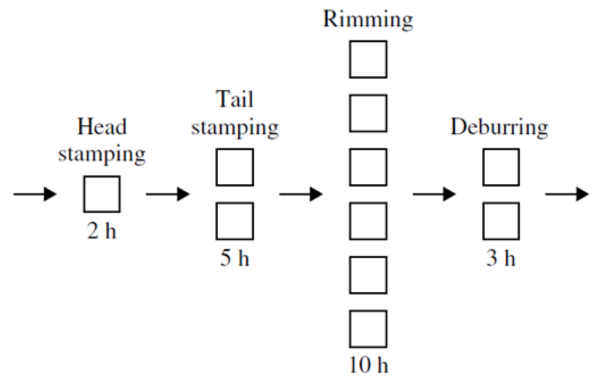
a) Compute the availability of Hare X19 and Tortoise 2000.

b) Plot a histogram of each case about more than 5000 cycle times by using Excel. The quantity of data should be comparable in both cases. (Submit the Excel file which contain CT values, histogram)

c) Compute the variance of cycle time in both cases and compare two variances. Is it consistent with our textbook? Explain why or why not.

Task 5 – Penny Fab - Multiple Machines, Exact Processing Times [HOMEWORK]

As illustrated in the following figure, Penny Fab produces giant pennies in four steps: punching, stamping, rimming, and deburring. Head stamping machine takes two hours, tail stamping takes five hours, rimming takes ten hours, deburring takes three hours.



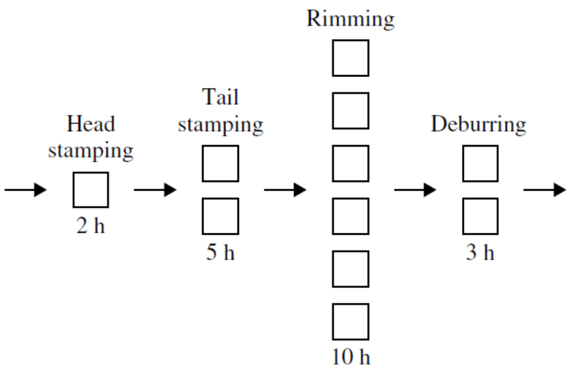
a) In case the processing times are **exact processing** times, the Increase WIP level from 1 to 15 and draw two graphs, TH vs. WIP and CT vs. WIP and analyze the result.
   - Is it consistent with Little's Law? Why or why not?

b) Suggest ways to increase TH by only changing the bottleneck station. Simulate your own model and analyze the result.

Task 6 - Penny Fab - Multiple Machines, Exp. Distribution

[HOMEWORK]

In time, Penny Fab is as illustrated in figure, and processing times for all machines follow exponential distribution. Head stamping machine takes two hours, tail stamping takes five hours, rimming takes ten hours, deburring takes three hours on average.



a) Increase WIP level from 1 to 20 and draw two graphs, TH vs. WIP and CT vs. WIP and analyze the result. Is it consistent with Little's Law? Why or why not?

b) Assume there is a balanced line with bottleneck rate and raw process time of Penny Fab in a). Increase WIP level from 1 to 20 and draw two theorical graphs, TH vs. WIP and CT vs. WIP (do not use simulation for this subtask).

c) Write down differences between the graphs in (a) and (b). Provide an explanation for the observed differences.

d) Look at the figure of the production line above: To which extend is it possible to transition from the unbalanced line in a) to the fully balanced line depicted in b)? Explain briefly.

Thank you

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