

Scope & Rationale

- HP is interested in the maximum utilization they can plan for each process while keeping the time material spends at each process reasonable (de-rates)
- Greater utilization = greater throughput, but with variability material time in system increases exponentially as utilization increases
- HP previously used de-rates from a 1998 analysis done on a similar system
- A 2019 MIME capstone project confirmed the values of the 1998 analysis using computer simulations of the processes, but limited their scope to only 1 machine per process. Team 205A furthered this project by providing calculations at one to four machines and completing sensitivity analysis on all 20 processes.

Sponsors: Hewlett Packard represented by Sharon LeRoux & Zac Jensen

Advisor: Dr. Hector Vergara

Mentor: Dr. Sarah Oman

Team Members: Will Kaigh & Michael Lynch

Hewlett Packard Utilization De-rates

This project calculates the utilization values for several processes with a varying number of machines to aid in production planning at HP

What is a process?

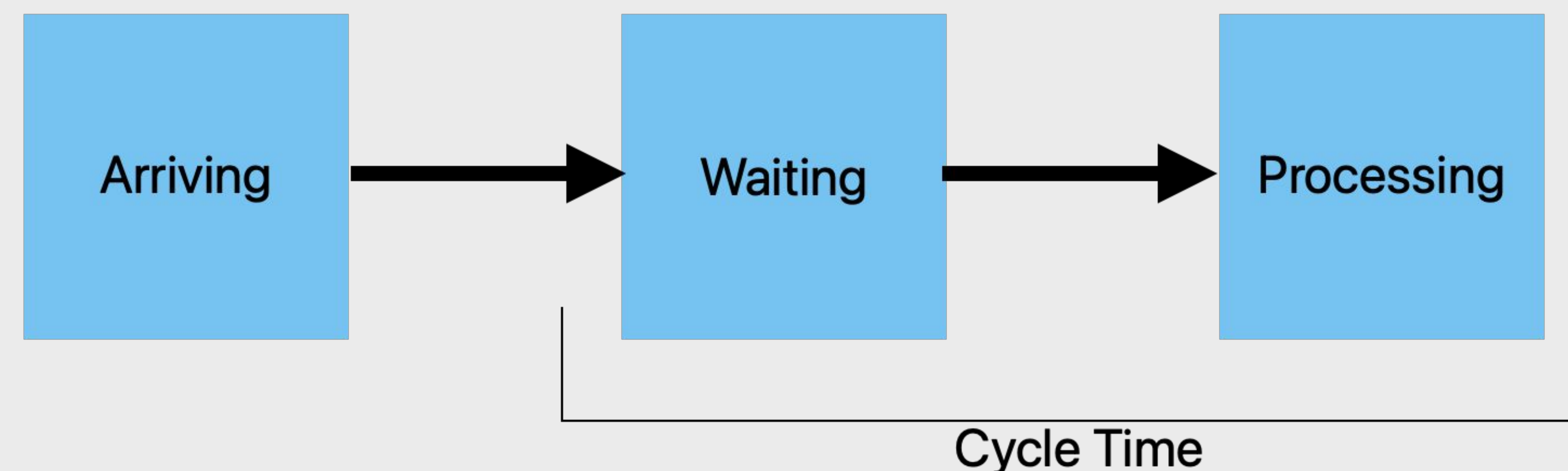


Figure 1: Example of a process modeled

Sensitivity Analysis

- The team completed sensitivity analysis for the 4 inputs: variation of processing time, variation of arrival rates, number of machines, and the cycle time target.
- Assessed sensitivity of individual variables by adjusting its value and recording the output value when the other 3 variables are held constant.
- Assessed sensitivity of combinations of variables by recording the output value while changing the values of all 4 variables simultaneously.
- The analysis identified what input values must be to significantly change utilization value (greater than ±10% change).

Outcomes

- The project successfully calculated utilization rates for each of the HP processes and the sensitivity of these rates relative to the input variables.
- A verified methodology to relate long-run cycle time values to utilization values given operational data of a process.
- Developed equations relating long-run utilization and cycle time values for each process in HP's panel production system.
- MatLab script tool to efficiently calculate and graph cycle time - utilization relationship sensitivity to a process' operating parameters.

Methodology

- Utilization is the percentage of time used out of total time, 100%.
- HP provided processing time data for each each of the processes. The times were given in the form of set-up time, run time, and unload time. most of the times followed a random distribution.
- The team used sums of random variables and Monte Carlo simulations to estimate variation of processing time
- Arrivals followed an exponential distribution so variation of arrival rate was 1 in each process
- HP provided the number of machines at each process
- The team used the equation for cycle time, derived from Kingman's Approximation, to calculate the estimated cycle time value for the system for a wide range of utilization values
- The team determined the cycle time output that was closest to the cycle time target, and identified its corresponding utilization value. This value represented the utilization of the process at the given cycle time target.
- The team used MatLab to automate this process for efficient calculations and sensitivity analysis.
- The graph below shows utilization for a process on the x-axis and cycle time on the y-axis with each line being a different number of machines.

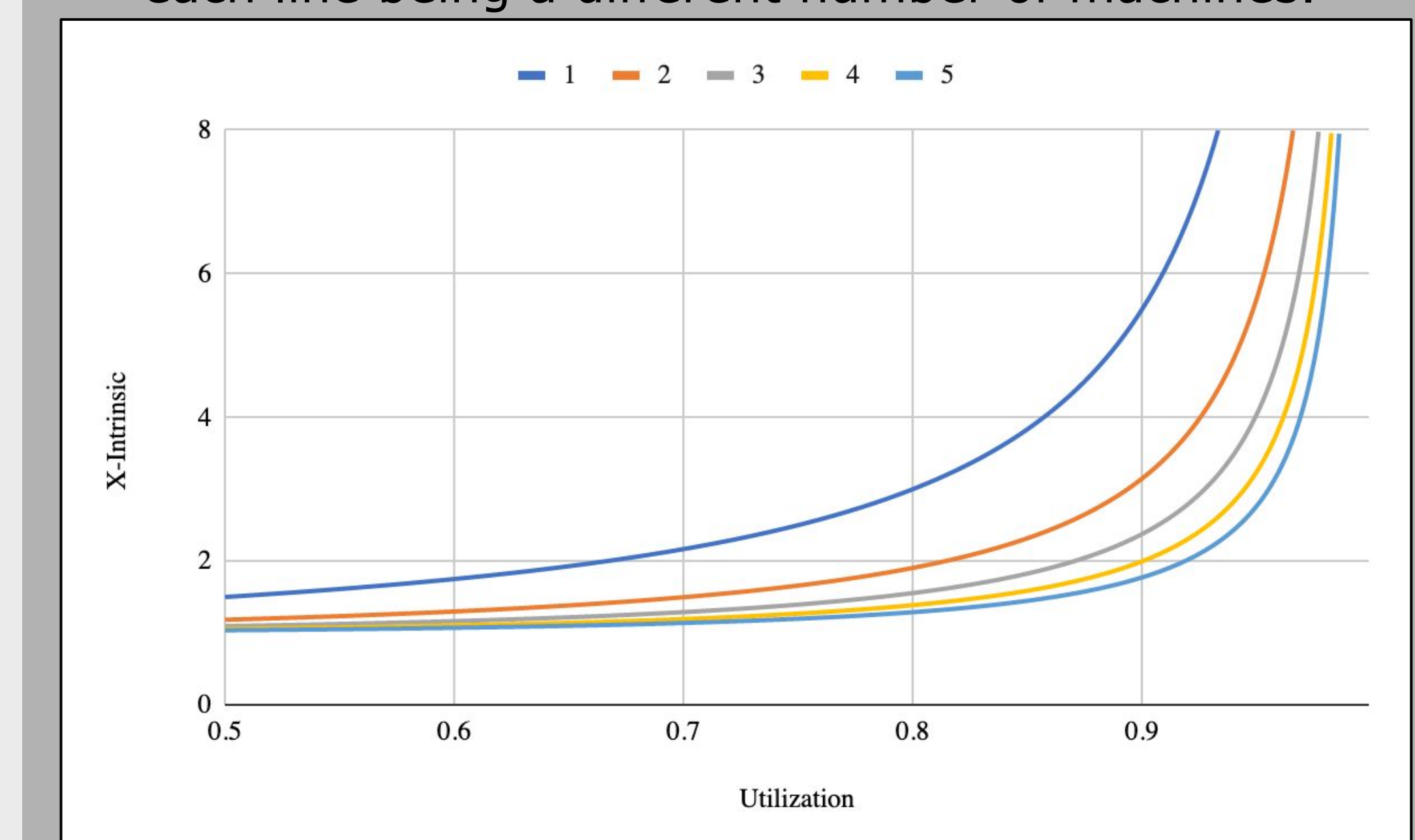


Figure 2: Utilization vs cycle time for 1-5 machines