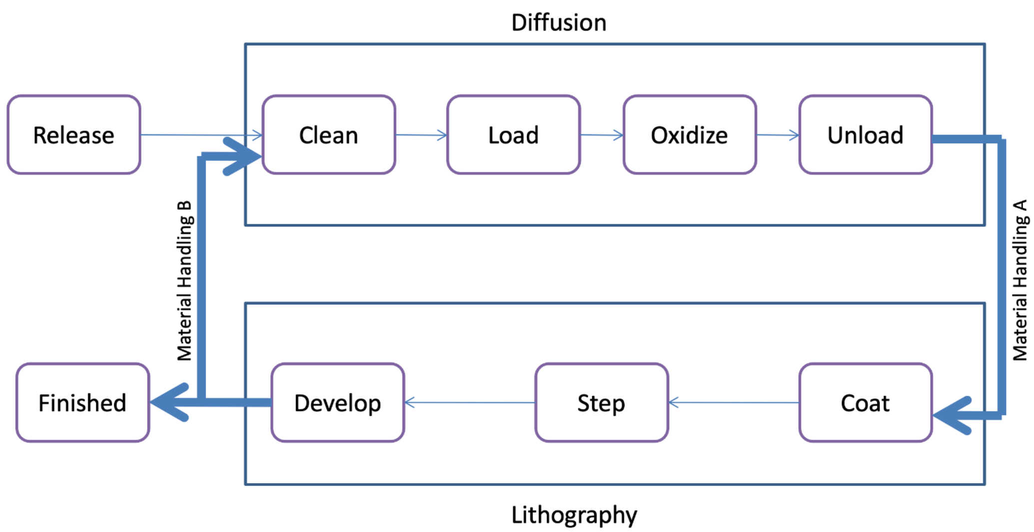
Project ISE 560, Presentation on 12/14 12:00pm and report Due on Dec 14^{th} 11:59pm

In this project, you will make recommendations on equipment purchases for a semiconductor manufacturer who plans to open a new plant. The process that they envision consists of the two basic steps shown, diffusion and lithography, each of which contains sub-steps, as indicated in the diagram.



Raw material will begin at the **Clean** step of diffusion, and after diffusion it proceeds to the lithography process. The diffusion and lithography processes then alternate until the product completes processing; reentrant flow is a characteristic of semiconductor manufacturing.

Movement of cassettes within each process (each of the thin arrows in the diagram) is handled by robots and takes very little time relative to the processing steps (5 minutes), so you can treat it as unconstrained. The movement of cassettes from the end of diffusion to the start of lithography, or from lithography to diffusion/finished (the **thick** arrows) is handled by distinct sets of workers (one set for A, the other for B). Movement of the cassette and return of the workers takes abour 20 minutes. You can assume the time is exponentially distributed. (HINT: you should treat the workers also as a server with an average processing time of 20 minutes)

Marketing has provided the following data on anticipated product mix:

Product types	**% of Mix**	**Diffusion Passes**	**Litho Passes**
C	60%	5	5
D	40%	3	3

[Note: This is a simplified, but nevertheless realistic, version of real semiconductor manufacturing. The key simplifications are a smaller number of passes of each step, and a simplified product routing.]

The mean time (in hours) per cassette for each step by product type are:

CLEAN	LOAD QTZ	OXIDIZE	UNLOAD QTZ	COAT	STEP	DEVELOP
2.0	0.25	2.35	0.25	1.375	1.175	0.50

Because the processes are new, these times are expected to be highly variable during the start-up phase, so it is reasonable to use exponential distributions.

[Processing times are quite variable in semiconductor manufacturing, but actually due to machine failures rather than the processing time itself being variable, but this is a reasonable approximation.]

Product will be released in cassettes with interarrival time follow an exponential distribution at the rate of 1 cassette/hour, 7 days a week, 24-hours a day (this is to achieve a desired throughput of 1 cassette/hour). Product is moved and processed in single cassette loads.

You have $60 million to spend to equip the factory. Your job is to find the combination of equipment that minimizes the long-run expected cycle time subject to the available budget. Equipment costs, per unit, are given below. It is not necessary to spend every dollar.

Step	**Cost per Unit ($Millions)**
CLEAN	1.1
LOAD QTZ	0.5
OXD	2.6
UNLOAD QTZ	0.5
COATER	0.9
STEPPER	1.8
DEVELOPER	0.2
MATERIAL HANDLING	1.0 (per worker)

Approximation: Determine the minimum number of each type of equipment that is needed just to keep up. Remember that to keep up maximum capacity > load is required, or in queueing theory terminology maximum service rate > arrival rate. Hint: Because of the reentrant flow, the arrival rate is NOT 1 cassette per hour in steady state.

These minimum numbers will provide the initial equipment level for your simulation, and tell you how much of your budget is remaining to spend.

Project: Determine an equipment purchase plan and justify it to management. Your audience is a mixed group of accounts, vice presidents and process engineers. Specifically, you can use a software or just do trial and error, to determine how many machines at each station and how many workers at set A and B that minimize the total cycle time. Characterize the queues of each station for your optimal setting.

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