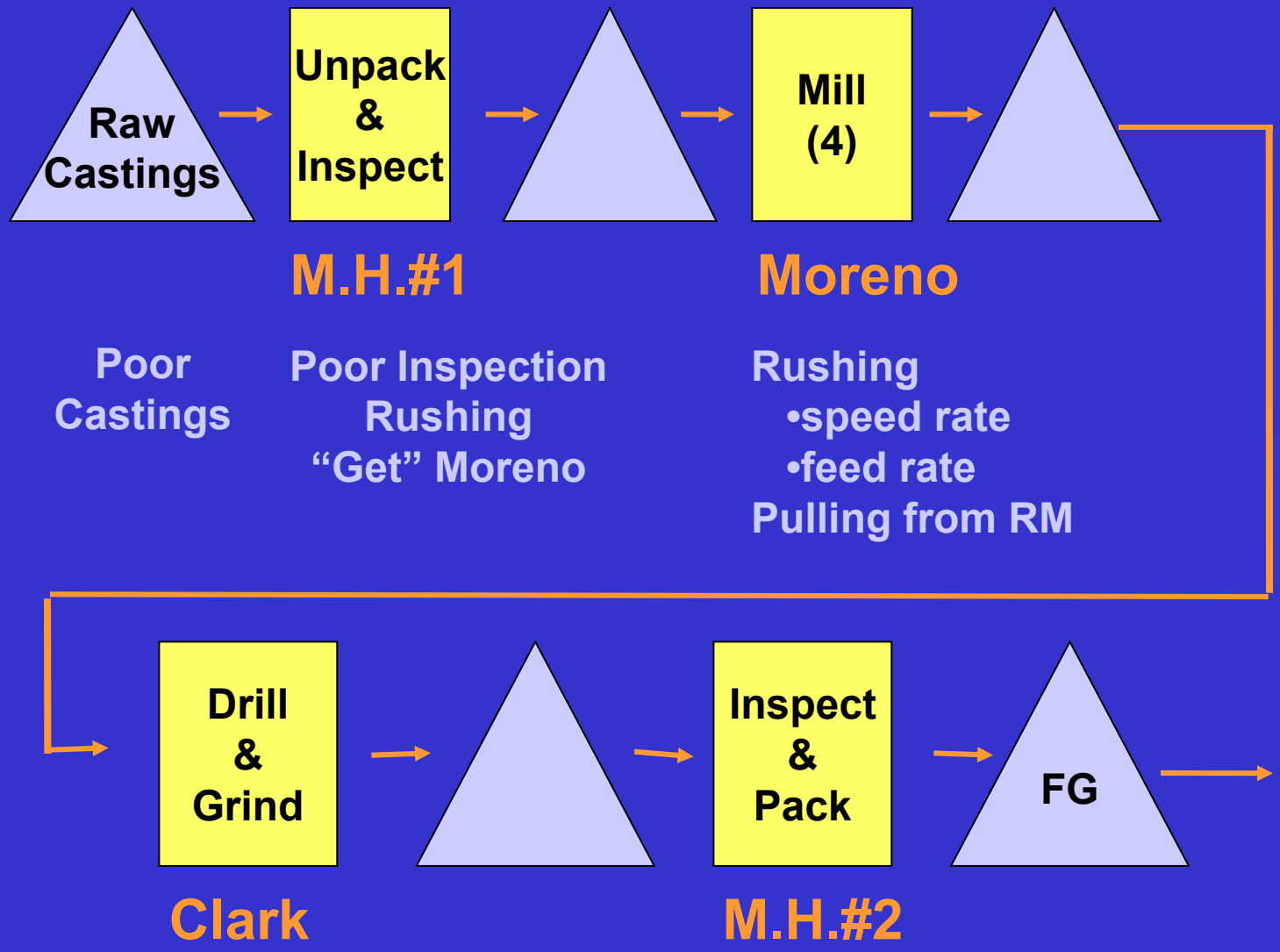


Types of Processes

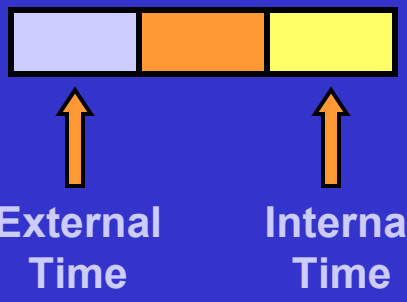
1. Project:
   - one-of-a-kind
   - e.g., Big Dig, Boeing
2. Job Shop:
   - large number of customized products
   - small quantities
   - e.g., machine shops, repair shops
3. Batch Process:
   - similar to a job shop, but…
     - larger batches (and setups)
     - more standardization
     - e.g., bookbinding
4. Line Flow Process:
   - a small number of standardized products
   - large quantities
   - e.g., auto plant
5. Continuous Process
   - similar to a line flow process, but…
     - the product is continuous
     - e.g., chemicals, steel mill, paper mill

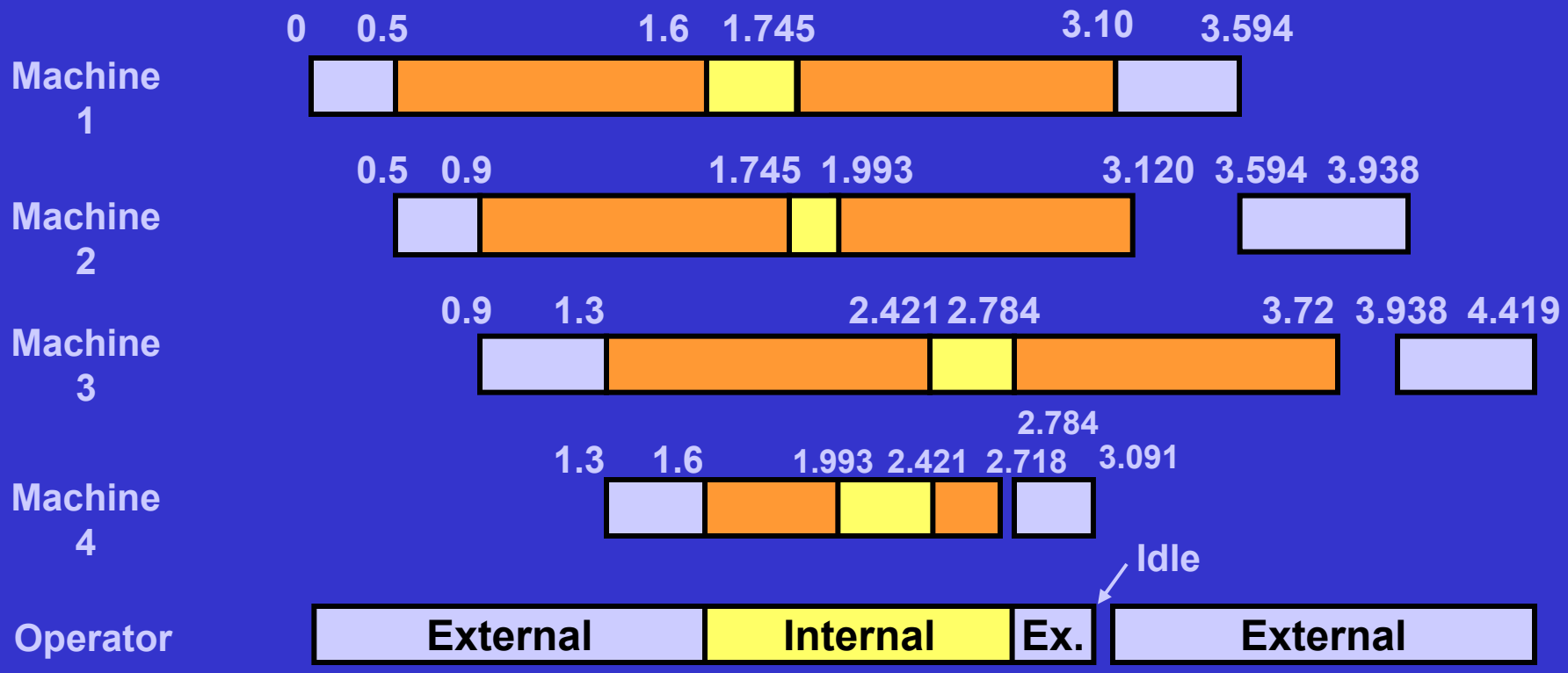
The process for the Pilgrim order is a worker-paced line flow process

Operation	Machine Time	External Time	Arbitrary Split	Internal Time
1	2.600	0.994	.50/.494	0.145
2	2.220	0.744	.40/.344	0.248
3	2.420	0.881	.40/.481	0.363
4	1.118	0.607	.30/.307	0.428

Fabritek Milling Operation

Standard Times





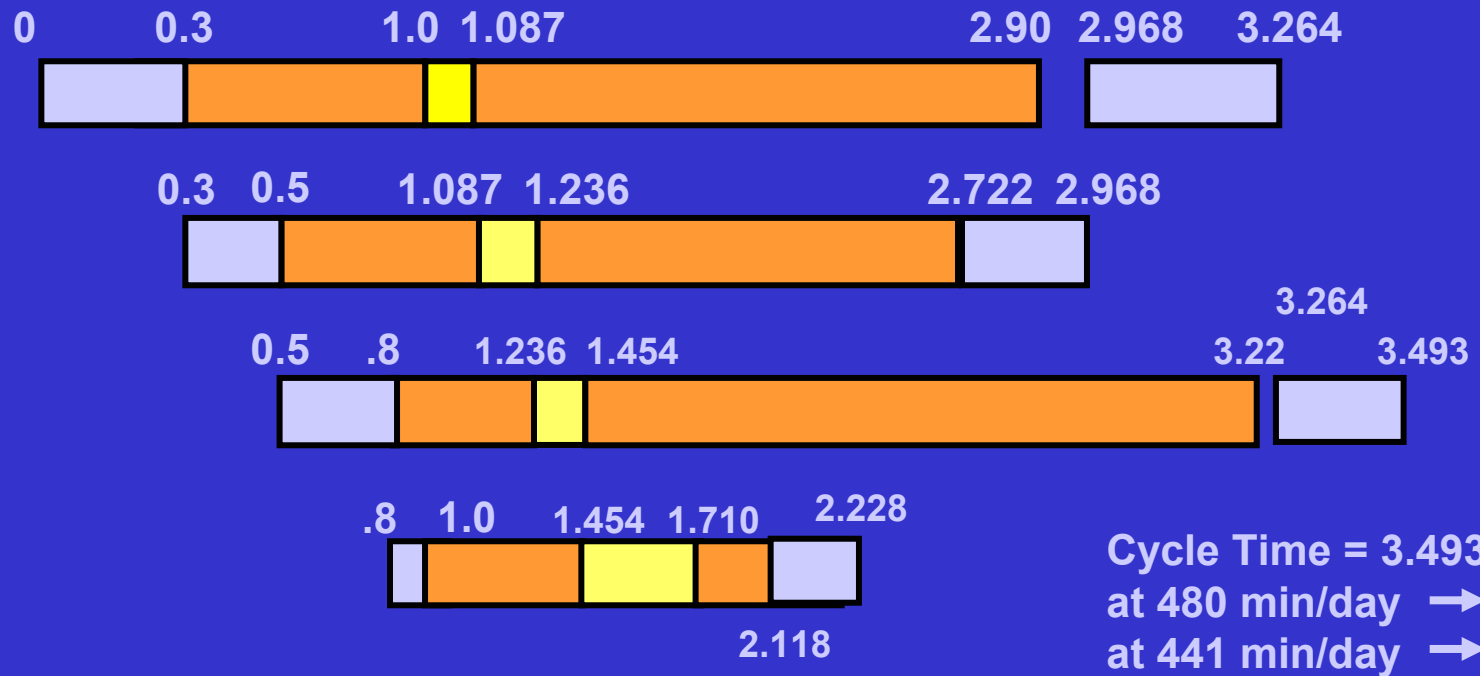
How many units per day can Moreno produce if...

- machine times stay the same?
- he takes no allowances?
- he performs external and internal tasks at 167% of standard?

ANSWER: About 137 units **(see the chart on the next page)**

	Machine Time	External Time	Arbitrary Split	Internal Time
	2.600	0.596	.30/.296	0.087
	2.220	0.446	.20/.246	0.149
	2.420	0.529	.30/.229	0.218
	1.118	0.364	.20/.164	0.256

*60% of standard time
(rate at 167% of STD)



Cycle Time = 3.493
at 480 min/day → 137 units
at 441 min/day → 126 units

How fast must Moreno be performing his tasks to earn 167%of Standard?

cycle time per unit = $\frac{480 min./day}{167 units/day}$ **= 2.874 min./unit**

Operation 1 is the bottleneck:
Ignore internal times and machines 2,3 and 4

$$2.6 + \frac{.994}{x} = 2.874 \Rightarrow x = 3.63$$

How much is Moreno speeding up the feed rate?

$$\frac{2.6}{y} + \frac{.994}{1.67} = 2.874 \Rightarrow y = 1.14$$

How do we meet Friday's order?

Action	Cost	Success	Implications
•Bribe Moreno	high	ok	UAW, co-workers?
•Replace Moreno	ok	enough time?	reward Moreno?
•Threaten to fire Moreno	ok	enough time?	lose best worker?
•Inspect output/ group incentive	high?	UAW?	correct message
•Add workers/OT/grinder	high	ok	ignore problem

Q: What are the systemic problems here?

Workers risk interference

- **poor quality inputs**
- **starvation**
- **no inspector**

Incentives: quantity, not quality
individual, not group
piece rate vs. hourly (inspectors)

Moreno a poor fit

No process discipline

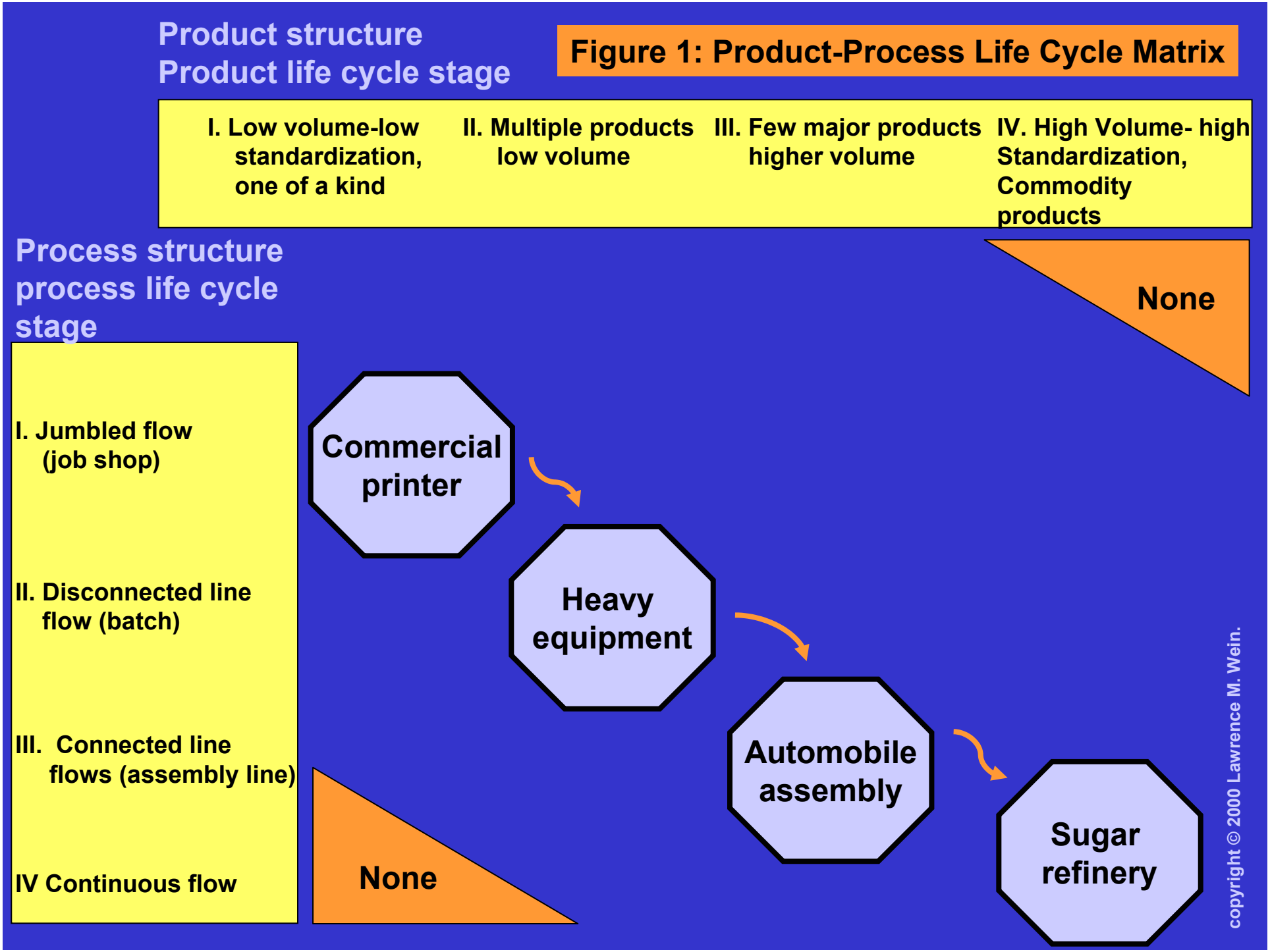
- **find out best way to do things**
- **develop documents**
- **train workers according to documents**
- **audit process**

Q: Would you pursue additional orders with Pilgrim?

If so, what changes are necessary?

- less skilled workers
- group incentives or hourly rate
- special purpose machinery
- no need for product engr. dept.
- line process (or special mfg. cell)
- optimize process (process discipline)

Figure 1: Product-Process Life Cycle Matrix



Product-Process Matrix

- coordinate manufacturing decisions (process type) and marketing decisions (market segment)
- most companies exploit competencies by living on diagonal
- 2 common traps
  - a) drift to (upper) right (Fabritek) $\Rightarrow$ lost opportunity costs
  - b) drift to (lower) left $\Rightarrow$ costly setups
- new developments (JIT, FMS, e-commerce) help companies move towards lower left corner

Wrap Up

1. Analysis leads to cause of problem
2. Incentive systems
3. Product-Process Matrix
4. Cellular Manufacturing

Key Definitions and Notation

λ = arrival rate (units/time)

μ = service rate (units/time)

M = number of servers

$\rho = \dfrac{\lambda}{M\mu}$

bottleneck = workstation with the highest utilization rate