Customer Choice

Introduction

Customer Choice for HP DeskJet Printers

How many HP printers are there on Amazon?

Why are there so many?

HP Deskjet printer (a look at Amazon)

- 1000 line
- 2000 line
- 3000 line
  - 3050 Printer Series
    - 3050 All-in-One
    - 3050A Wireless All-in-One
- 4000 line
- 5000 line
- 6000 line

=> A printer for every day of the year…

Customer Choice in Henry Ford's Days

Henry Ford: "You can have any color of a car, as long as it is black"

Why did Ford not offer color?

Actually, he did

Production reasons to keep the cars (a) in one color (b) black

In this module, we discuss different types of product variety; we discuss the benefits, but also explore the costs associated with variety

End of intro lecture

Forms of Variety - Fit Based Variety

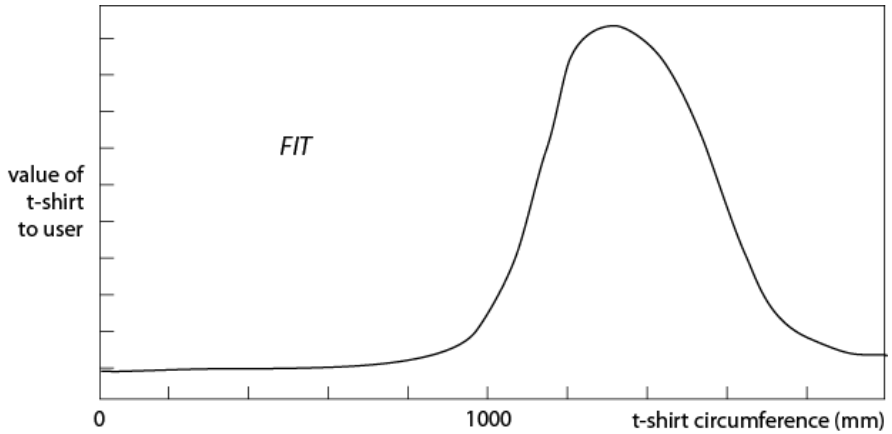
Customers differ in shirt sizes

Each customer has a unique utility maximizing shirt size

The further you go away (in either direction) from that point, the lower the utility

Hotelling's linear city

Example: sizes, locations, arrival times



Source: Ulrich

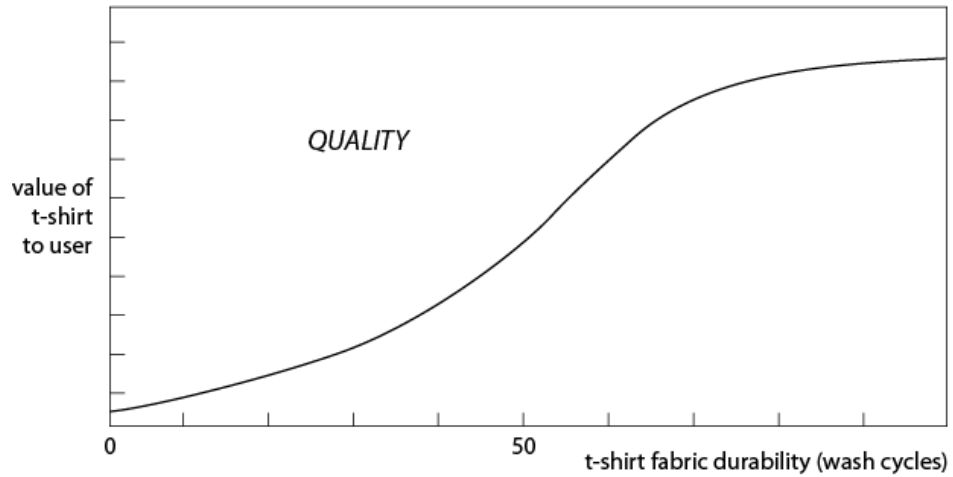
Forms of Variety - Performance Based Variety

Each customer prefers the high end model

Customers differ in their valuation of quality (performance) and/or their ability to pay

Vertical differentiation

Example: screen resolutions, mpg, processor speeds, weight



Source: Ulrich

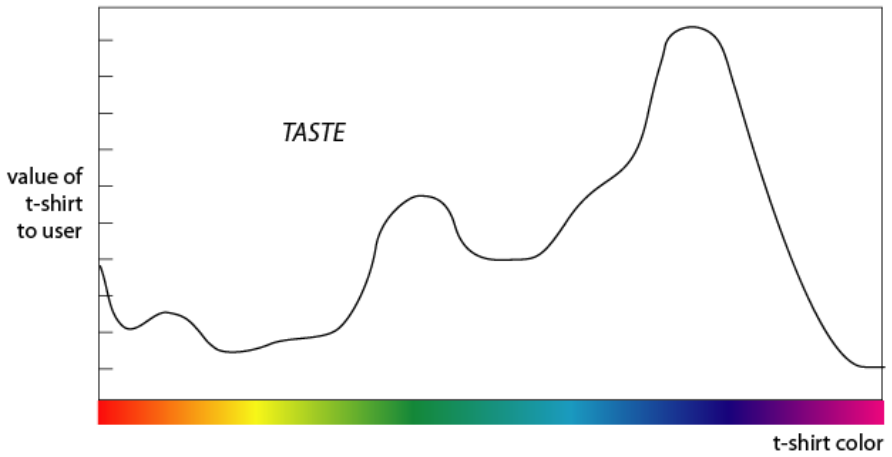
Forms of Variety - Taste Based Variety

Customers differ in their preferences for taste

Often times, these preferences vary over time

Rugged landscape

Example: taste for food, music, artists



Economic Motives for Variety

- Heterogeneous preferences of customers
- Price discrimination
- Variety seeking by consumers
- Avoiding price competition in channel
- Channel self space
- Niche saturation and deterrence to market entry

Source: Ulrich

Customer Choice

Impact on process capacity

Ordering Custom Shirts

Custom shirts ordered online

Large variety of styles

Basically infinitely many sizes

Four weeks lead time

Minimum order: 5 shirts

Custom Tailored Shirts: Production Process

Cutting Department
The pattern is programmed into a machine and/or a cutting template is created. This takes a certain amount of set-up time IRRESPECTIVE of how many shirts will be produced afterwards.

Sewing Department
Sewing Section – Cut pieces of fabric are sewn together and inspected
Assembly Section - Responsible for assembling shirts and measuring the size.

Finishing Department
Responsible for ironing shirts before folding, packaging and delivery to customers.

Source: http://hosting.thailand.com/MWT00255/process1.htm

Process Analysis with Batching

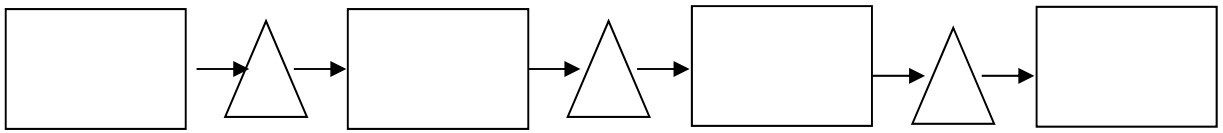
- Example: Cutting Machine for shirts
  20 minute set-up time (irrespective of the number of shirts)
  4 minute/unit cutting time
  15 Shirts in a batch

- Capacity calculation for the resource with set-up changes:

$$\text{Capacity given Batch Size} = \frac{\textit{Batch Size}}{\textit{Set-up time} + \textit{Batch-size}*\textit{Time per unit}}$$

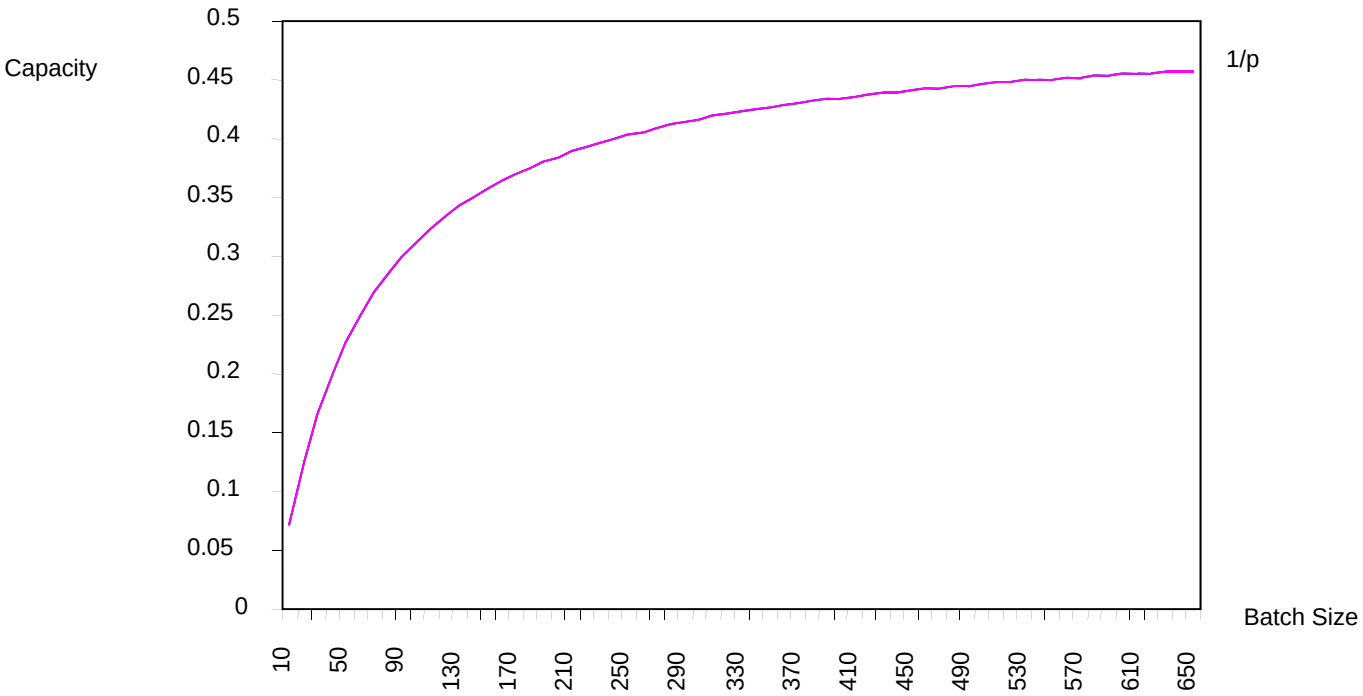
Example Calculations

What is the capacity of the cutting machine with a batch size of 15?



Set-up time:	20 minutes	-	-	-
Processing time:	4 min/unit	40 min/unit	30 min/unit	3 min/unit
Resources:	1 machine	8 workers	5 workers	1 worker

Large Batches are a Form of Scale Economies



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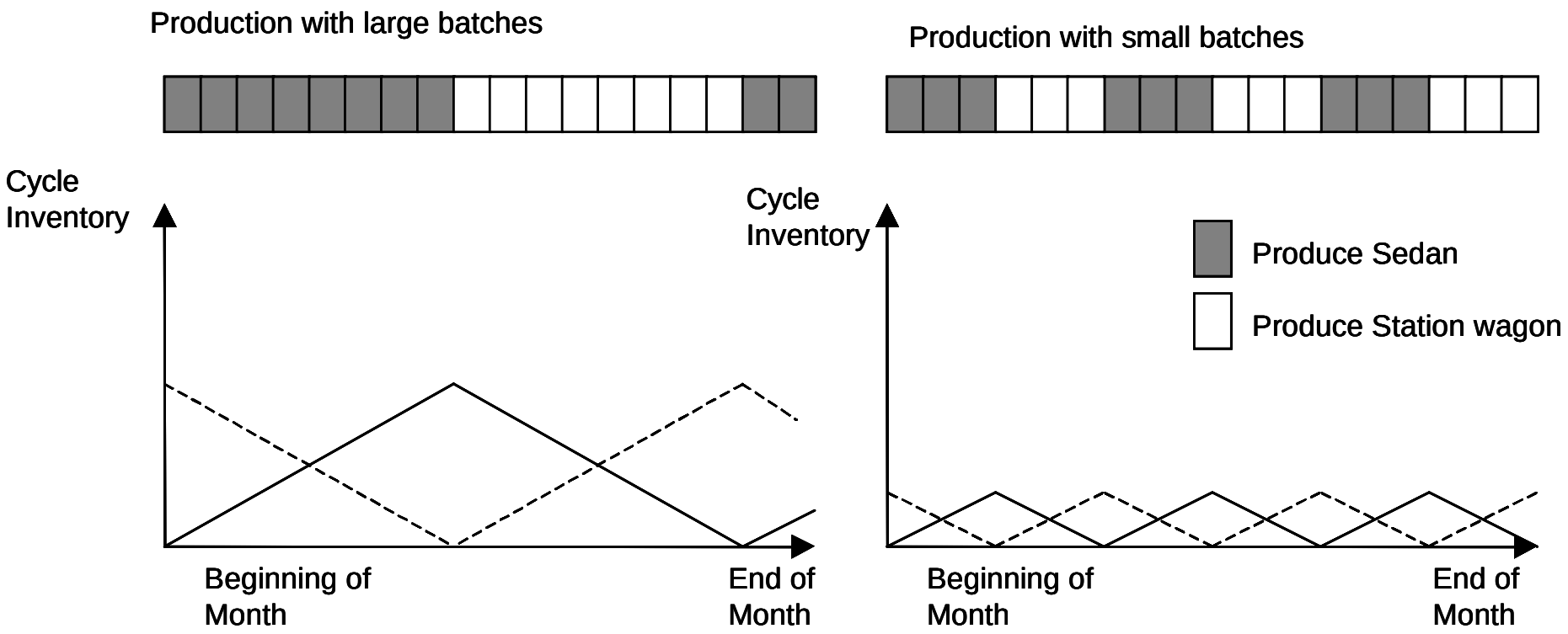
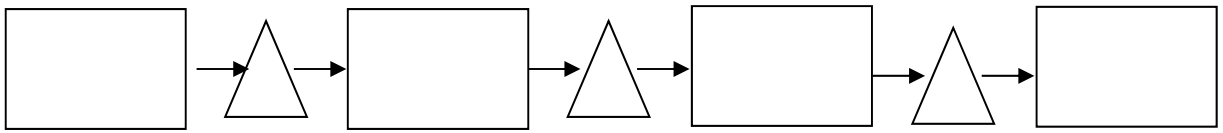
Choosing a good batch size

The Downside of Large Batches



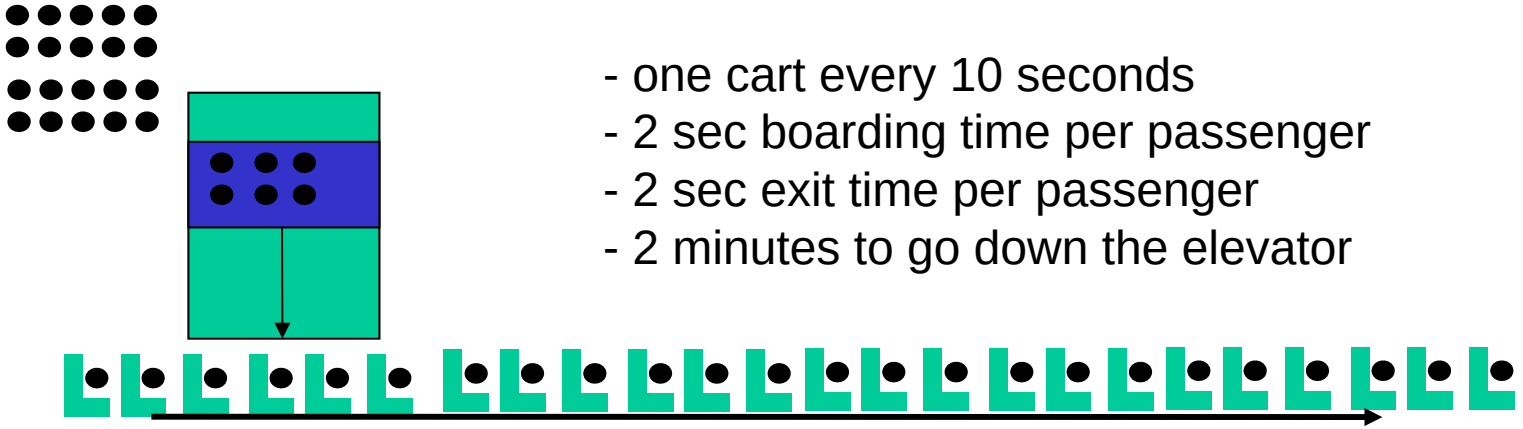
- Large batch sizes lead to more inventory in the process
- This needs to be balanced with the need for capacity
- Implication: look at where in the process the set-up occurs
  - If set-up occurs at non-bottleneck => decrease the batch size
  - If set-up occurs at the bottleneck => increase the batch size

Example Calculations



Set-up time:	20 minutes	-	-	-
Processing time:	4 min/unit	40 min/unit	30 min/unit	3 min/unit
Resources:	1 machine	8 workers	5 workers	1 worker

How to Set the Batch Size – An Intuitive Example



- one cart every 10 seconds
- 2 sec boarding time per passenger
- 2 sec exit time per passenger
- 2 minutes to go down the elevator

$$\text{Capacity given Batch Size} = \frac{\textit{Batch Size}}{\textit{120sec + Batch-size*4sec}}$$

$$\text{1/10 [units/sec]} = \frac{\textit{Batch Size}}{\textit{120sec + Batch-size*4sec}}$$

$$\text{Batch Size} = 20 \text{ units}$$

Process Analysis with Batching: Summary

- Batching is common in low volume / high variety operations
- Capacity calculation changes:

$$\text{Capacity given Batch Size} = \frac{\textit{Batch Size}}{\textit{Set-up time} + \textit{Batch-size}*\textit{Time per unit}}$$

- This reflects economies of scale (similar to fix cost and variable cost)
- You improve the process by:

Setting the batch size:

(a) If set-up occurs at the bottleneck => Increase the batch size

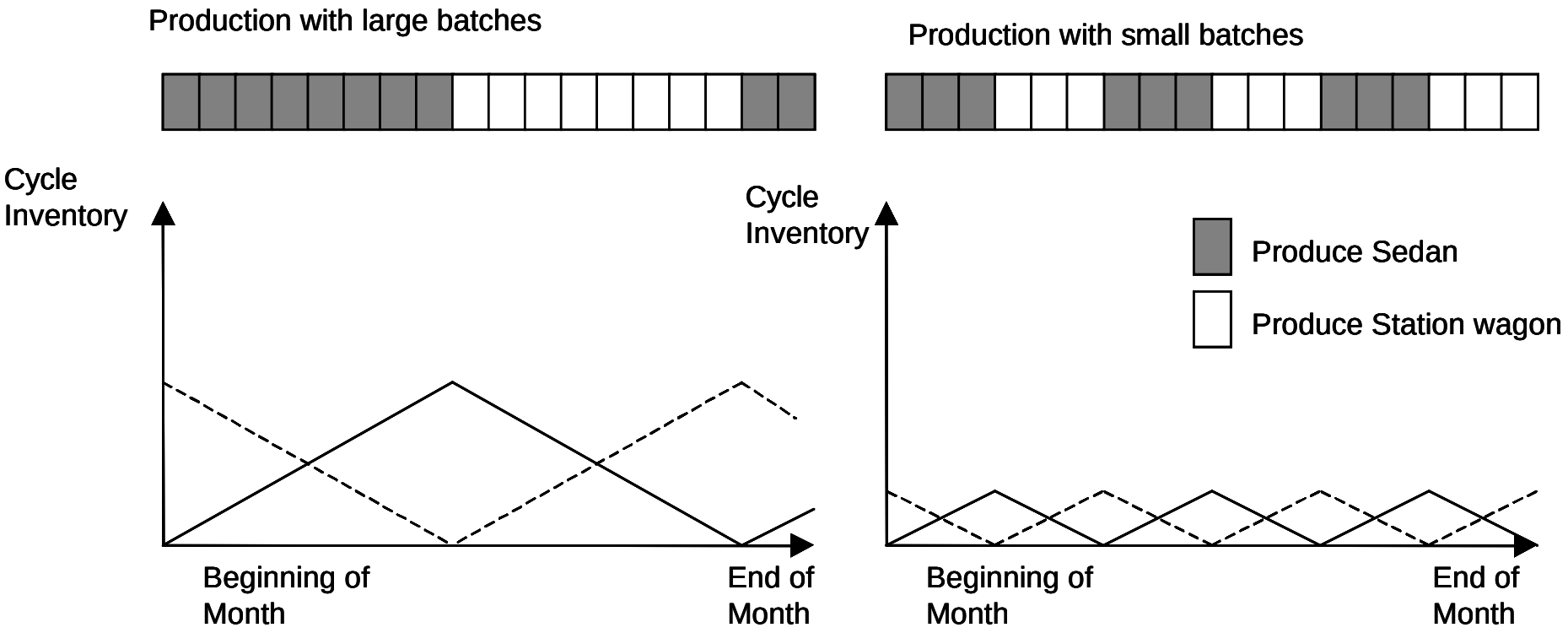
(b) If set-up occurs at a non-bottleneck => Reduce the batch size

(c) Find the right batch size by solving equation

Customer Choice

Understanding the Diseconomies of Scale
Extra inventory

The Downside of Large Batches



- Large batch sizes lead to more inventory in the process
- This needs to be balanced with the need for capacity

General Definition of a Batch

Product A: Demand is 100 units per hour
Product B: Demand is 75 units per hour

The production line can produce 300 units per hour of either product

It takes 30 minutes to switch the production line from A to B (and from B to A)

How would you set the batch size?

Introducing a Third Product into the Product Line

Consider a company that has two products, product A and product B.

Product A: Demand is 100 units per hour
Product B: Demand is 75 units per hour

The production line can produce 300 units per hour of either product (takt time: 12 sec/unit)

It takes 30 minutes to switch the production line from A to B (and from B to A)

How would you set the batch size?

$$\text{Required Flow Rate} = \frac{\textit{Batch Size}}{\textit{Set-up time} + \textit{Batch-size}*\textit{Time per unit}}$$

$$\text{175 units per hour} = \frac{\textit{Batch Size}}{\textit{1 hour} + \textit{Batch-size/300 hour}}$$

Batch size = 420

Batch size for A= 420 * 100 / (100+75) = 240
Batch size for B=420-240=180

Introducing a Third Product into the Product Line

Now, the Marketing folks of the company add a third product. Total demand stays the same.

Product A1: Demand is 50 units per hour
Product A2: Demand is 50 units per hour
Product B: Demand is 75 units per hour

How would you set the batch size?

Introducing a Third Product into the Product Line

Now, the Marketing folks of the company add a third product. Total demand stays the same (maybe they do this because they can raise prices). Say they offer product A in two colors.

Product A1: Demand is 50 units per hour
Product A2: Demand is 50 units per hour
Product B: Demand is 75 units per hour

How would you set the batch size?

$$\text{Required Flow Rate} = \frac{\textit{Batch Size}}{\textit{Set-up time} + \textit{Batch-size}*\textit{Time per unit}}$$

$$\text{175 units per hour} = \frac{\textit{Batch Size}}{\textit{1.5 hour} + \textit{Batch-size}/\textit{300 hour}}$$

Batch size = 630

Batch size for A1= 630* 50 / (50+50+75) = 180
Batch size for A2= 630* 50 / (50+50+75) = 180
Batch size for B= 630* 75 / (50+50+75) = 270

Customer Choice

Pooling Effects / Demand Fragmentation

Demand Fragmentation

You have 3 products (different shirt sizes)

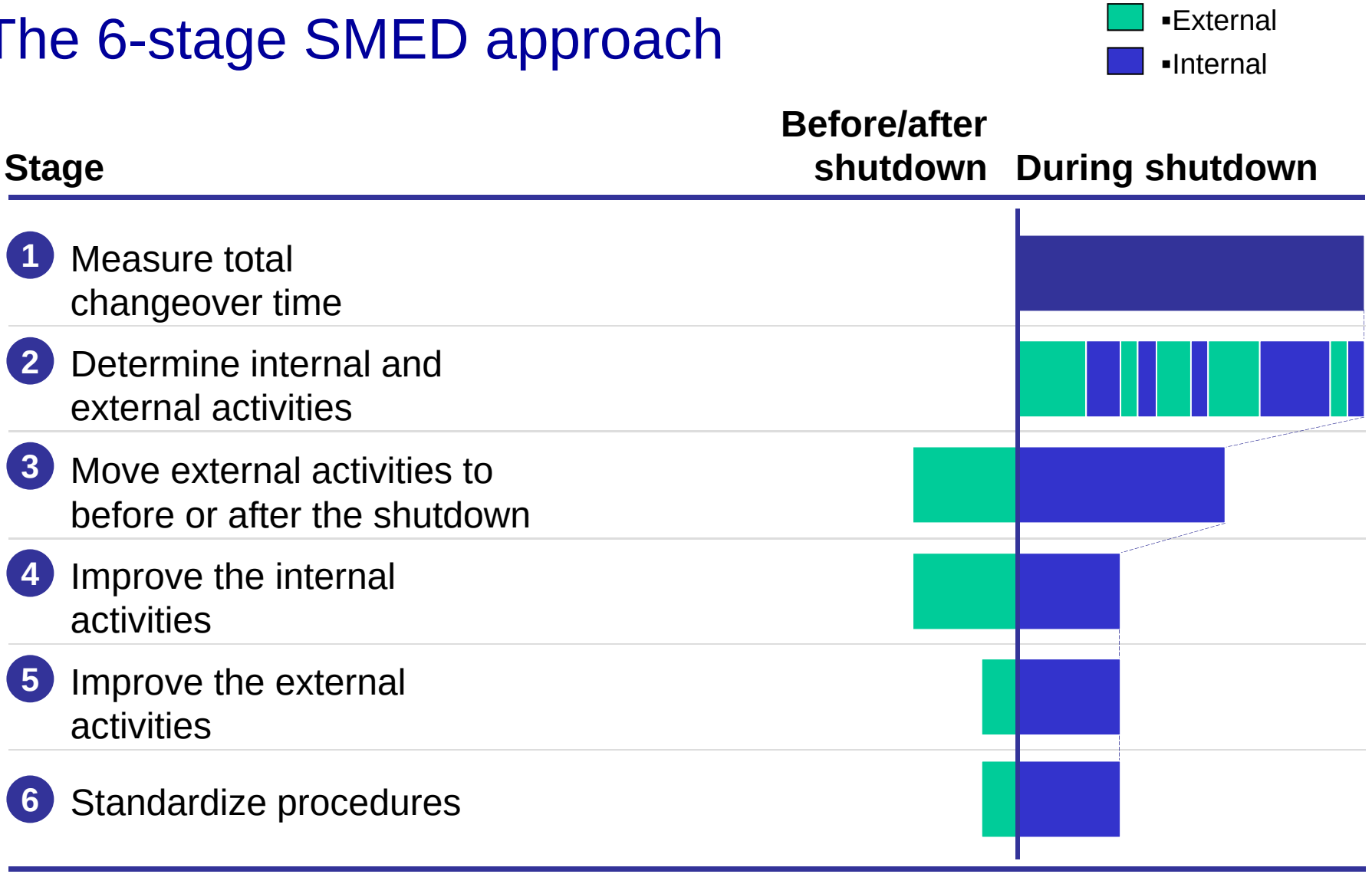
Demand for each product could be 1, 2, or 3 with equal (1/3) probability

How good is your forecast FOR YOUR OVERALL SALES?

Customer Choice

Building Flexibility: SMED / Heijunka

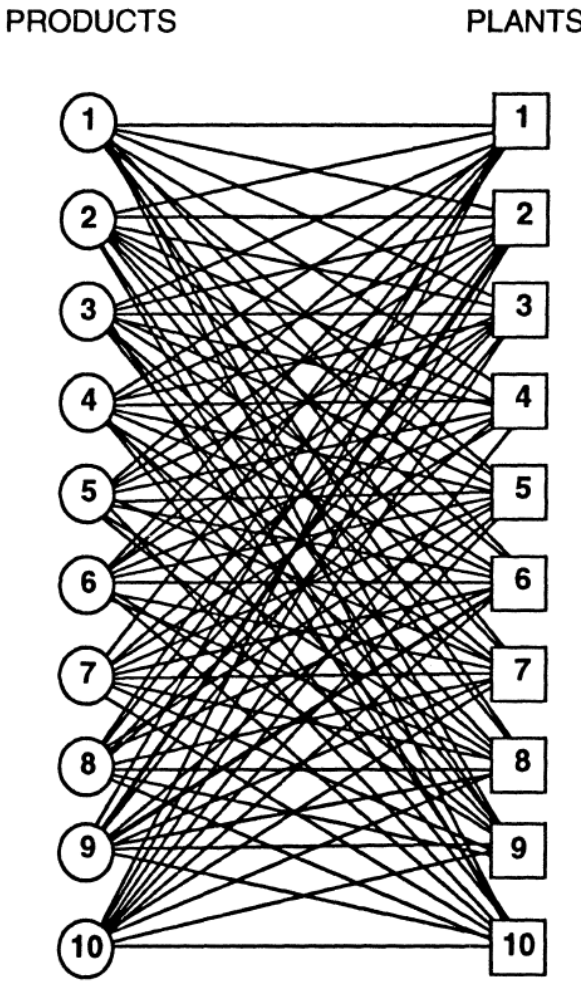
The 6-stage SMED approach



Reduce set-up so that you can change models as often as needed
=> Mixed model production (Heijunka)

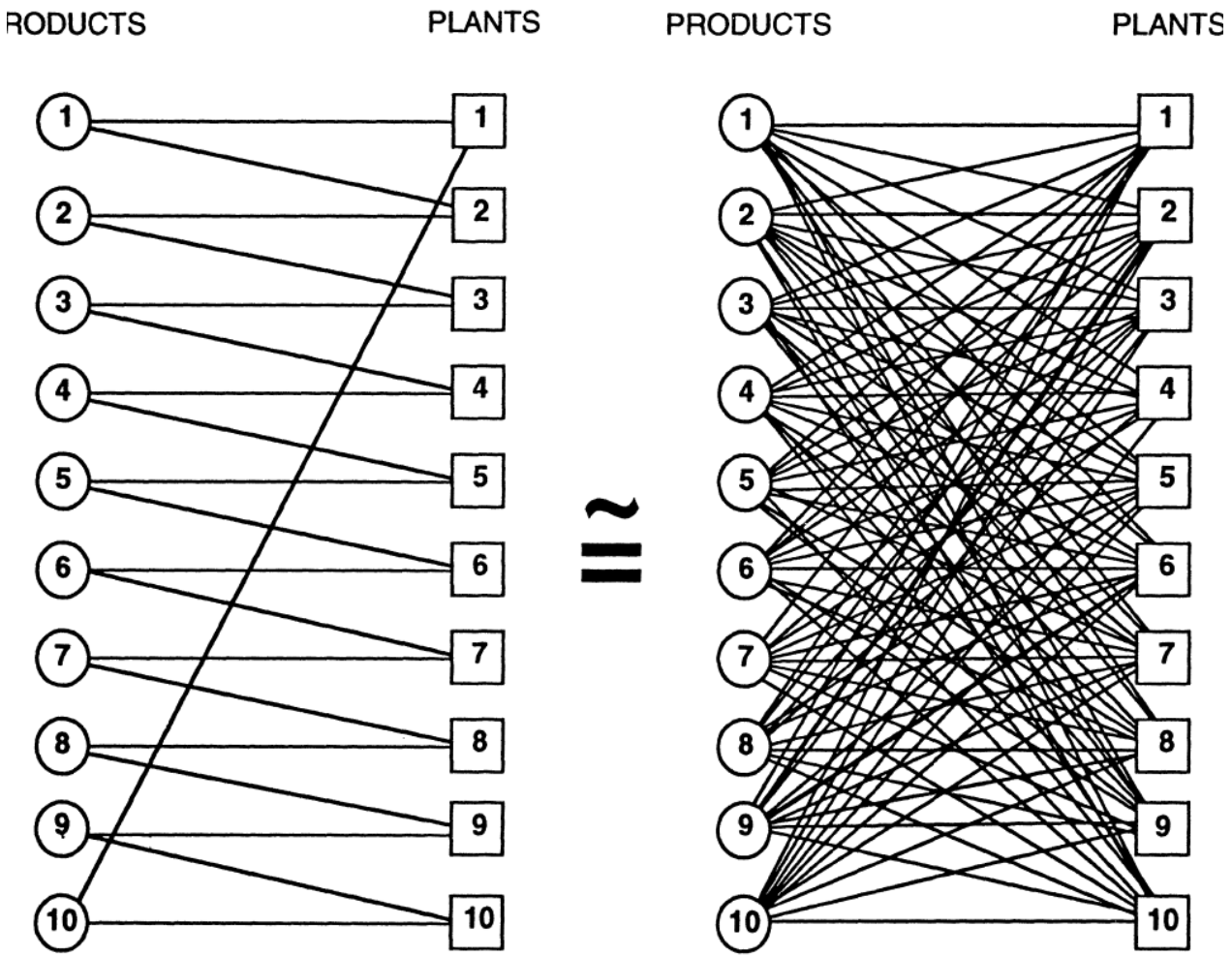
Source: McKinsey Ops Training Material

Full Flexibility



Source: Jordan and Graves

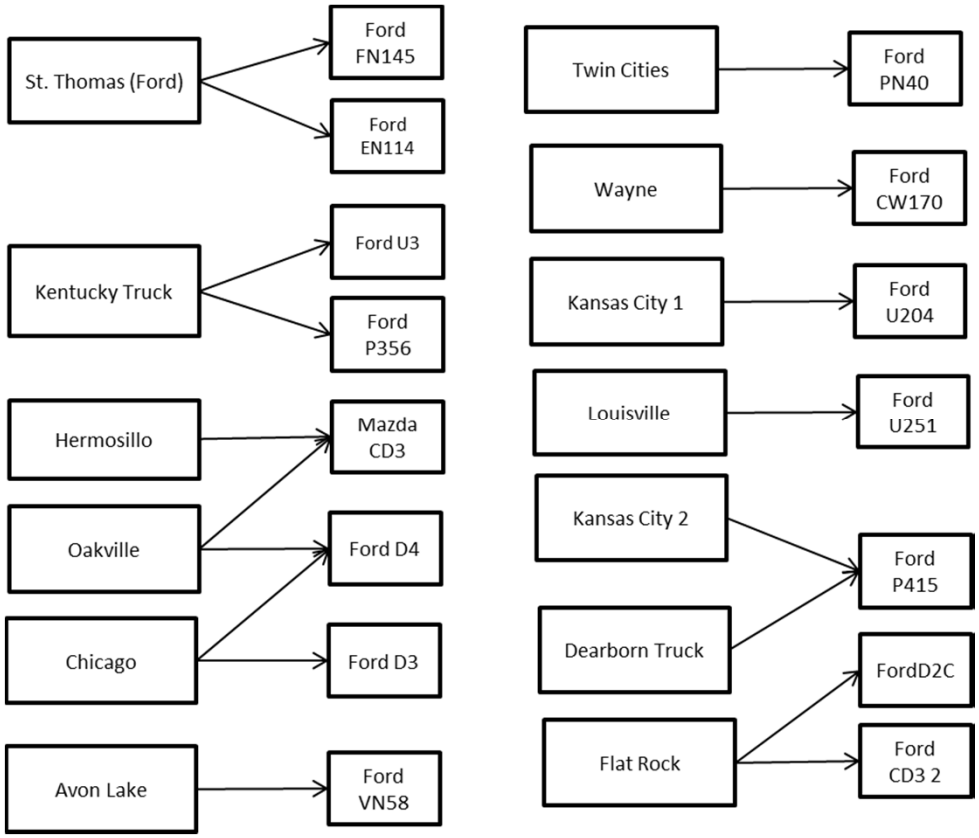
Flexibility vs Chaining



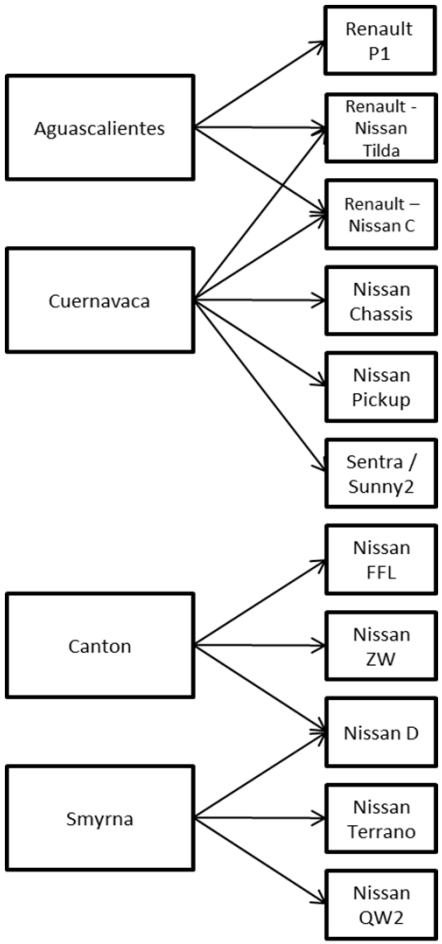
Source: Jordan and Graves

Pooling vs Chaining

Ford's manufacturing network



Nissan's manufacturing network



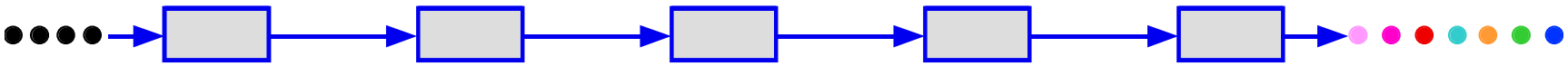
Chaining is a form of partial flexibility ("pooling" light)
Does not require full flexibility, but relies on a clever product-to-plant assignment

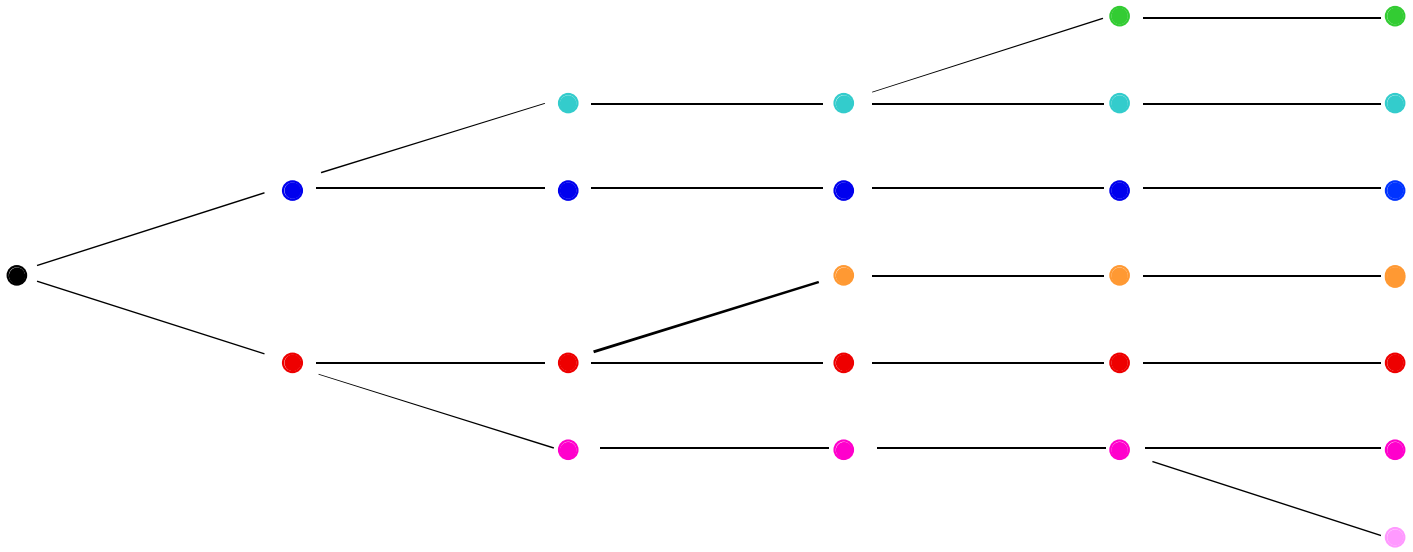
Source: Moreno and Terwiesch

Customer Choice

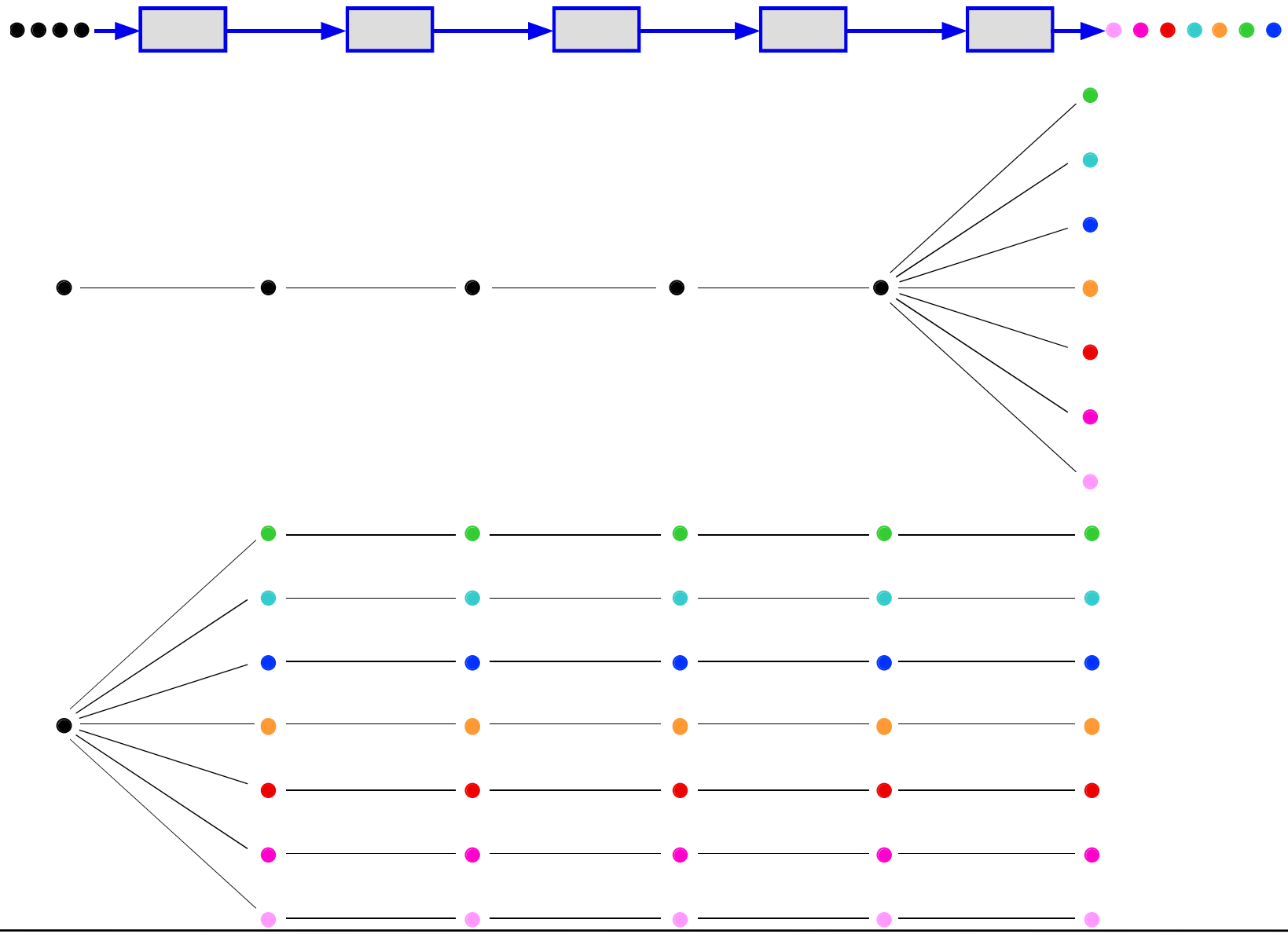
Strategies to deal with variety / Investing in flexibility

Design for supply chain performance



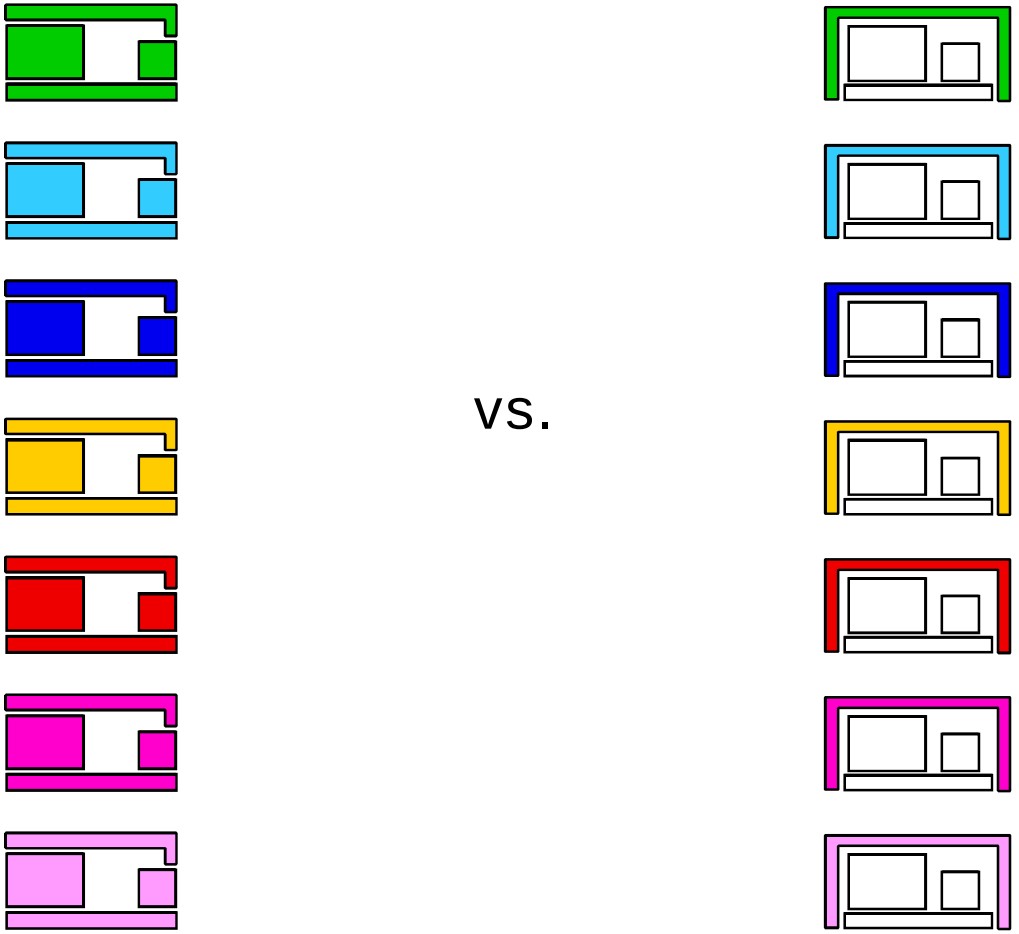


Design for supply chain performance



Source: Ulrich

Isolate the variable elements of the product

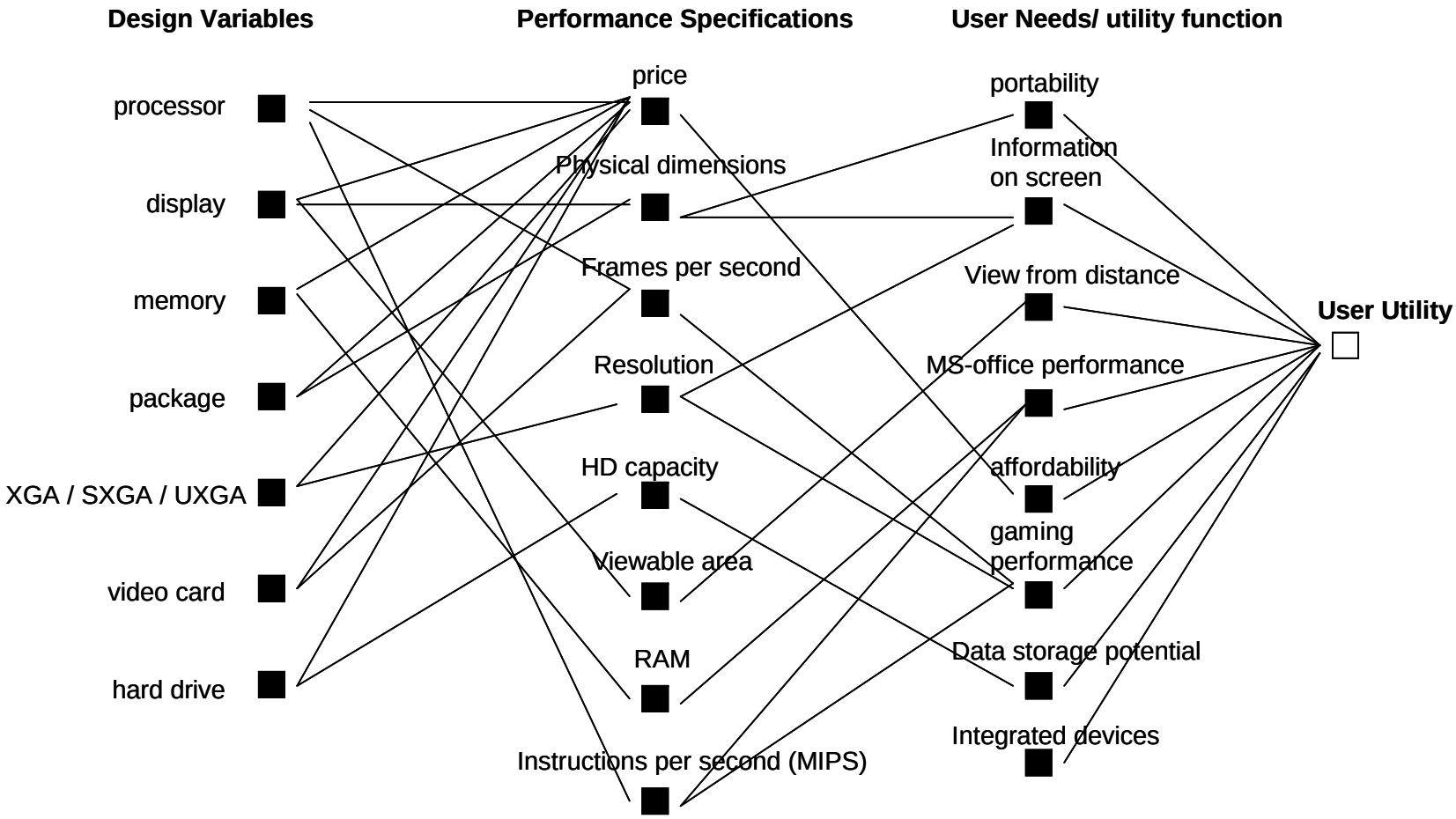


Source: Ulrich

Customer Choice

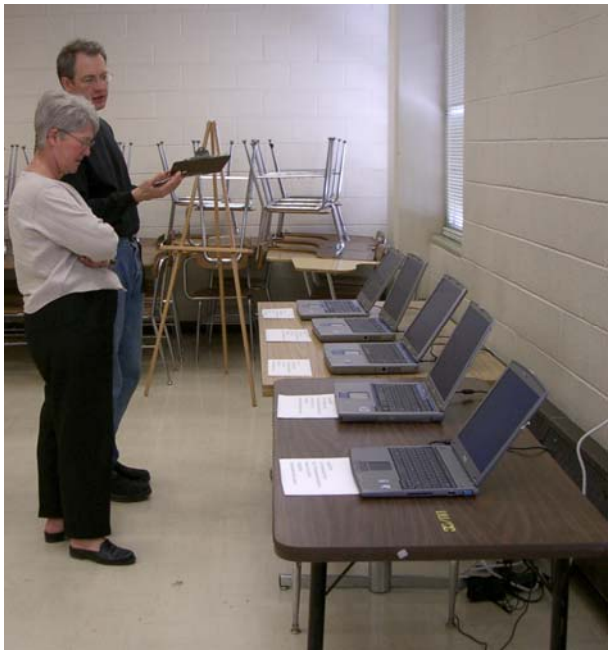
Limits to customization

Introduction



Source: Randall, Terwiesch, Ulrich

Introduction



Customer Choice

Review Session

Window Boxes

Metal window boxes are manufactured in two process steps: stamping and assembly. Each window box is made up of three pieces: a base (one part A) and two sides (two part Bs).

The parts are fabricated by a single stamping machine that requires a setup time of 120 minutes whenever switching between the two part types. Once the machine is set up, the processing time for each part A is one minute while the processing time for each part B is only 30 seconds.

Currently, the stamping machine rotates its production between one batch of 360 for part A and one batch of 720 for part B. Completed parts move from the stamping machine to the assembly only after the entire batch is complete.

At assembly, parts are assembled manually to form the finished product. One base (part A) and two sides (two part Bs), as well as a number of small purchased components, are required for each unit of final product. Each product requires 27 minutes of labor time to assemble. There are currently 12 workers in assembly. There is sufficient demand to sell every box the system can make.

a. What is the capacity of the stamping machine?

b. What is the capacity of the overall process?

c. What batch size would you recommend for the process?

(Gelato) Bruno Fruscalzo decided to set up a small production facility in Sydney to sell to local restaurants that want to offer gelato on their dessert menu. To start simple, he would offer only three flavors of gelato: fragola (strawberry), chocolato (chocolate), and bacio (chocolate with hazelnut). Demand is 10kg/hour for Fragola, 15 for chocolate, and 5 for Bacio.

Bruno first produces a batch of fragola, then a batch of chocolato, then a batch of bacio and then he repeats that sequence. After producing bacio and before producing fragola, he needs 45 minutes to set up the ice cream machine, he needs 30 minutes to change to Chocolato and 10 minutes to change to Bacio.

When running, his ice cream machine produces at the rate of 50 kg per hour no matter which flavor it is producing (and, of course, it can produce only one flavor at a time).

a. Suppose Bruno wants to minimize the amount of each flavor produced at one time while still satisfying the demand for each of the flavors. (He can choose a different quantity for each flavor.) If we define a batch to be the quantity produced in a single run of each flavor, how many kilograms should he produce in each batch?

b. Given your answer in part (a), how many kilograms of fragola should he make with each batch?

SmartPhone

Apfel is a German company selling smart-phones. Presently, the company is only selling a 64GB model. The marketing department recently proposed to add a 128 GB model. Preliminary data suggests that (a) the margins for the product will increase (b) the total sales will remain the same and will be split 50:50 between the two models (c) there exists a mild positive correlation in the demand between the two models.

Consider the following statements:

1. The coefficient of variation of the 64GB phone will go down
2. The coefficient of variation of the 64GB phone will stay constant
3. The coefficient of variation of the 64GB phone will go up
4. It would be nice for the production and distribution process if the memory component, which is the only difference between the two models, would be inserted early in the process.
5. It would be nice for the production and distribution process if the memory component, which is the only difference between the two models, would be inserted late in the process.

Which of the above statements is true?

1+4
1+5
2+4
2+5
3+4
3+5