Management of Uncertainty

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Outline

- Forecasting
- Managing uncertainty
- Aggregation/risk pooling
- Postponement
- Mixed strategies
- Lead time management

Supply Chains are Tough to Manage

- Supply chains are difficult to manage – regardless of industry clockspeed (although more difficult in fast clockspeed industries)

- Managing inventory is one of the difficulties, ranging from shortages as we see for Goodyear racing tires to excess inventory as we see in Cisco's high-tech networking products. The impact of the inventory challenges affect employment levels as we see how GM used layoffs to adjust inventory product price; as we see Palm cut prices to deal with excess inventory profits; as we see USX's net income sink

- It is a cyclical problem that has extremes as we see in Intel's case, going from shortages and backlogs to chip gluts back to shortages

- Supply chains are tough to manage even if you are the dominant player.

Four Rules of Forecasting

1.
2.
3.
4.

Why is the World Less Certain

- Aggravated bullwhip; higher variance; irrelevant history
- Much more difficult to forecast

Managing Uncertainty

1. Point forecasts are invariably wrong
2. Aggregate forecasts are more accurate
3. Longer term forecasts are less accurate
4. In many cases somebody else knows what is going to happen

⇨ Plan for forecast range – use flexible contracts to go up/down

⇨ Aggregate the forecast - postponement/risk pooling

⇨ Shorten forecasting horizons – multiple orders; early detection

⇨ Collaborate

Managing Uncertainty

- Centralized inventory (aggregation, risk pooling) – less safety stock
  - Pronounced with high variability and negative correlation
- Postponement
  - Reduction in forecast horizon beyond the pivot point
  - Risk pooling in “core” product
  - Built-to-order
- Lead time reduction
  - Proximity; process re-engineering, I/T

Risk Pooling

- Temporal – over time
- Geographically – over areas
- By product line – or product family
- By consumer group - socio-economic characteristics

Forecast Error

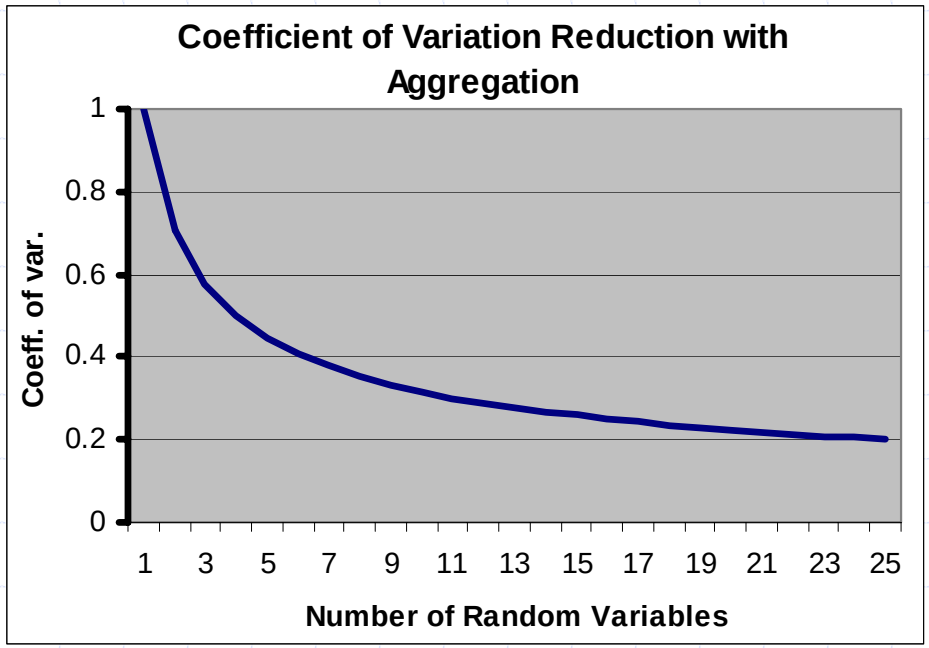
- How does one measure accuracy?
  - Variance
  - Absolute error
  - RMSE
- Coefficient of variation C.V. = StdDev/Mean)
- C.V. always smaller for *aggregate* forecast
- Negative correlation reduces forecast errors even further

RMSE is based on the difference between the forecast and the realization. If the forecast is static and so it is the mean, the RMSE is actually the variance.

Effects of Aggregate Forecast

The coefficient of variation for n independent random variables with mean μ and standard deviation σ:

$$CV = \frac{1}{\sqrt{n}} \bullet \frac{\sigma}{\mu}$$



The effects of correlation:
Negative: stronger aggregation effects
Positive: less aggregation effect

Risk Pooling

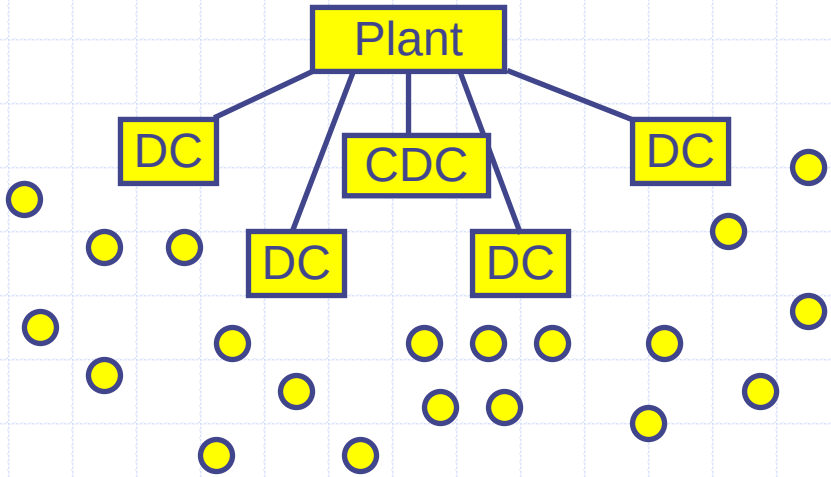
- Why do "big box" stores do well?
- Imagine an urban area with nine store
  - Each store sells a mean of μ = 50/wk with a standard deviation of σ = 35/wk
  - Lead time = 2 weeks For 97.5% service, Store Safety Stock= 1.96•35•1.41=97 items
  - Total safety stock = 9•97=873 items
- Now replace these stores with a single super-store
  - The super-store sells a mean of μ = 450/wk with a standard deviation of σ = 3•35 /wk = 105/wk
  - For 97.5% service, the super-store Safety Stock= 1.96•105•1.41=291 items
- Note: the inventory required to cover the lead time does not change (900 units). The difference is in the safety stock.

($\sqrt{2}$ = 1.41)

Big Store

- Advantages:
  -
  -
  -
  -
  -
- Disadvantages:
  -
  -

Centralized Inventory



20 stores (5 per DC)
LOS: 97.5%
Store Demand = 50±35
Replenishment time = 1 week

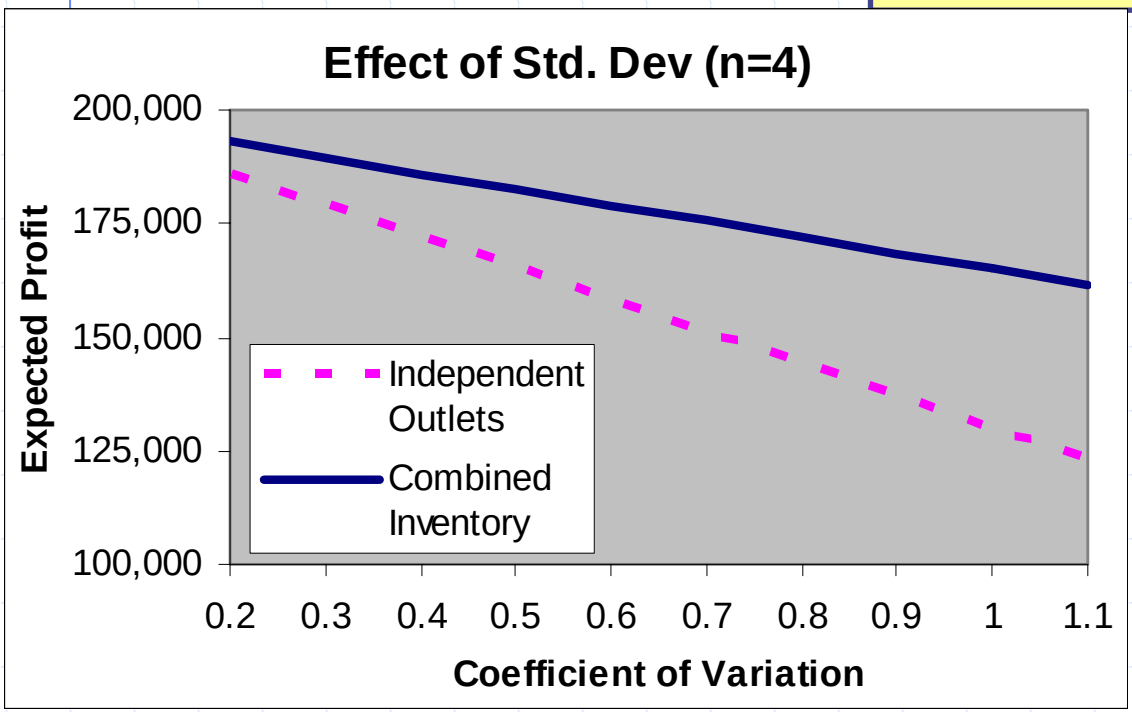
Each DC Demand = 5•50±SQRT(5)•35 = 250±78
CDC Demand = 20•50±SQRT(20)•35 = 1,000±156

Total safety stock at stores = 20•(50+1.96•35) = 2,372
Total safety stock at DC-s = 4•(250+1.96•78) = 1,612
Total safety stock at CDC = 1,000+1.96•156 = 1,306

Aggregation with a Single Order

Each of 4 stores:
Price: $150
Cost : $50
Salvage: $25
Mean: 500
Std. Dev: 150

Each:
Q* = NORMINV(0.8, 500, 150) = 626
Profits = $44,751
4 independents: $179,003
Combined
Q* = NORMINV(0.8, 2000, 300)= 2,252
Profits = $189,501



Big change:
sold items up 1.73%
unsold items dn 50.00%

Shirt Postponement

Regular operation: import shirts from the far East (4 wks lead time)
Need: LOS = 97.5%

Postponement: bring Greige colors and dye to order

Color	Demand		Transit Inv	safety Stock	Total Inv
	Mean shirts/wk	Std Dev shirts/wk			
Red	1,500	500	6,000	1,960	7,960
Blue	1,200	450	4,800	1,764	6,564
Green	600	250	2,400	980	3,380
Black	2,500	700	10,000	2,744	12,744
Total (Individual Shirts)			23,200	7,448	30,648
Total (postponed)	5,800	1,002	23,200	3,930	27,130

- Safety stock
- Owned inventory

Uncertainty Management:

Examples: Risk Pooling and Postponement

- Cadillac automobiles in Florida
- Benetton for sweaters and T-shirts
- HP European printers
- Gillette for blades in Europe
- Sherwin Williams paint
- Motorola modems
- Zara Fabrics
- Dell build-to-order

Build-to-Order

- The ultimate postponement
- Dell/Gateway build-to-order
  - Better response to changes in demand
  - Better response to changes in component pricing/availability
  - Ability to direct customers to products including existing components
- The “Pivot” point: from BTS to BTO
  - Pushing the customization/commitment later in the supply chain

Postponement

Mean demand = 800
Standard deviation = 400
Price = $40
Cost = $18
Salvage = $5

Order size for each color = 931 sweaters
Total order = 3,724 sweaters
Expected profit for each color = $12,301
Total profit = **$49,230**

2,790 sold; 934 unsold

Make “Griege” sweaters and die to demand

Mean demand = 3,200
Standard deviation = 800
Cost = $21
Salvage = $5

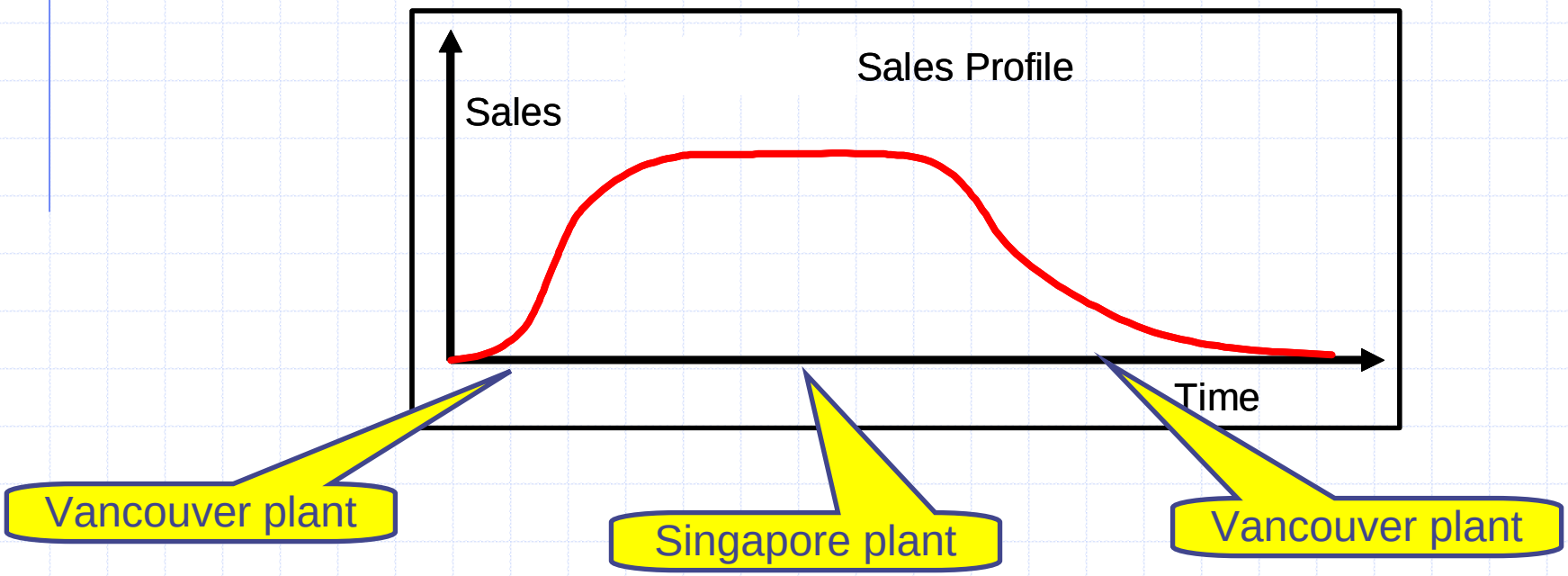
Order size for each color = 3,286 sweaters
Expected total profit = **$53,327**

3,026 sold; 260 unsold

A Mixed Strategy

- Idea: order some pre-colored sweaters and sell those first
- Order also some griege sweaters and sell them as demand materializes
- Question: how many of each to maximize profit
- Use: simulation
- Answer:
  - Only colored: order 931 of each 3,724 Tot.): Exp. profit: $49,230
  - Only griege: order 3,280: Exp. Profit: $53,327
  - 600 colored each and 1,100 griege: Exp. profit: $54,487

HP Printers for the US



Multiple Orders (QR)

Price	$120
Cost	$40
Salvage	$25
Mean (1 period)	50
Std. Dev	25

Order once for the whole period:

Mean = 100; Std. Dev = 35.4

Q* = 135

Exp. Profits = $7,190

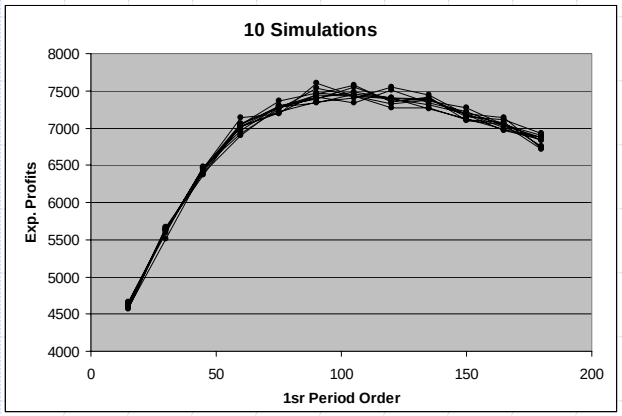
Order at the beginning & again in mid period:

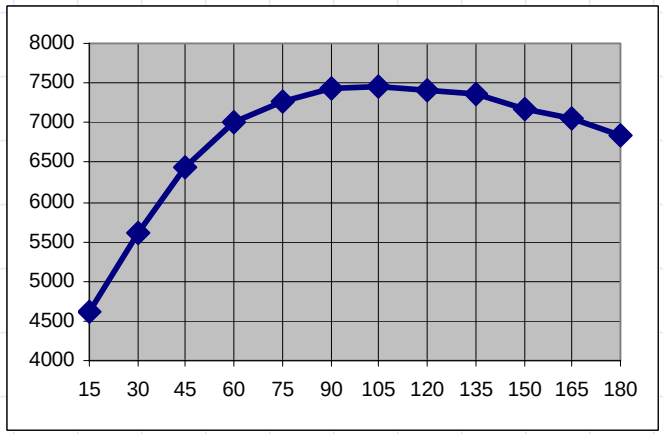
2nd period:

Mean = 50; Std. Dev = 25

Order "up to": = 75

How much in 1st period?





Q* ≅ 104; Exp Profits = $7,450

Asymmetric Aggregation

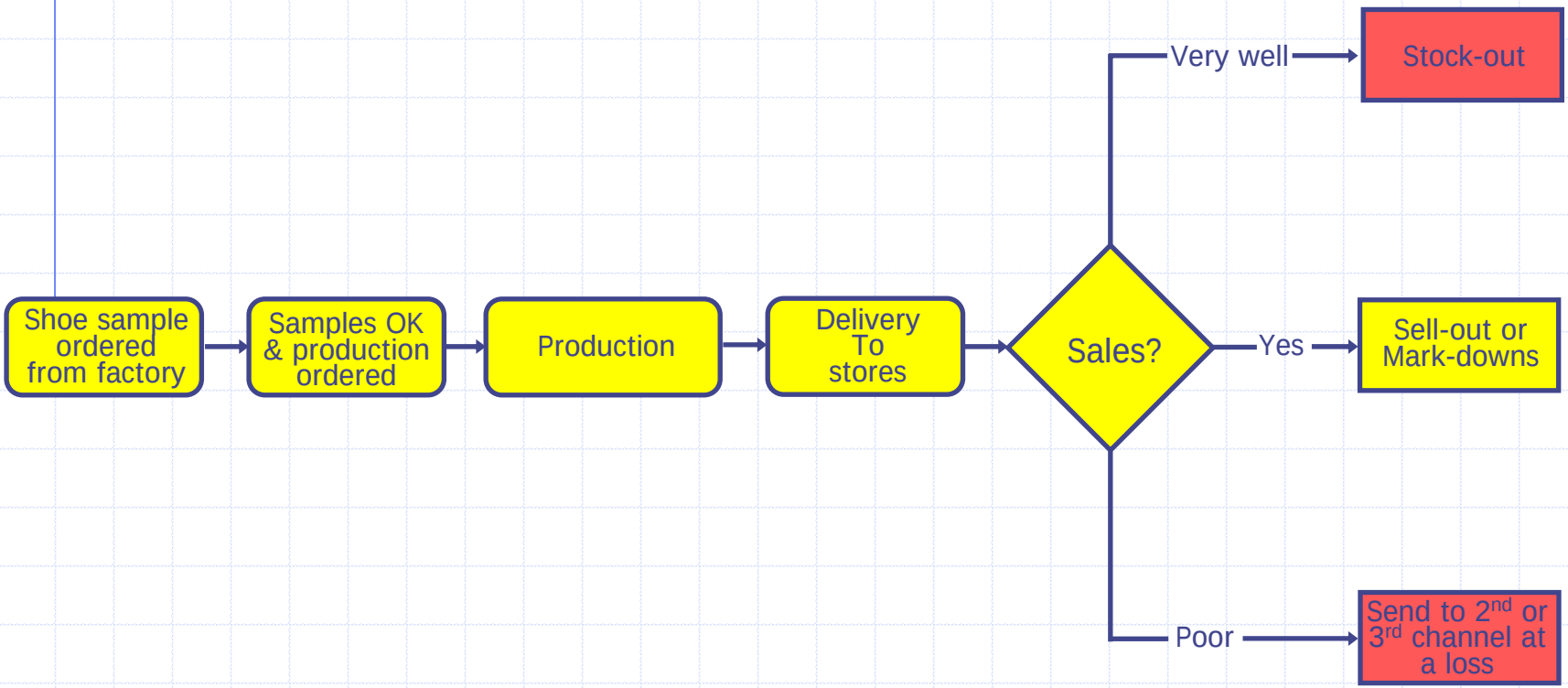
- You can always upgrade to keep consumers happy
- Example: two-cars automobile rental company: Buick and Cadillac
- Assume: equal demand (order 500 each for independent demand)
- For upgrade option: order more Cadillacs and less Buicks

Uncertainty Management: Lead Time

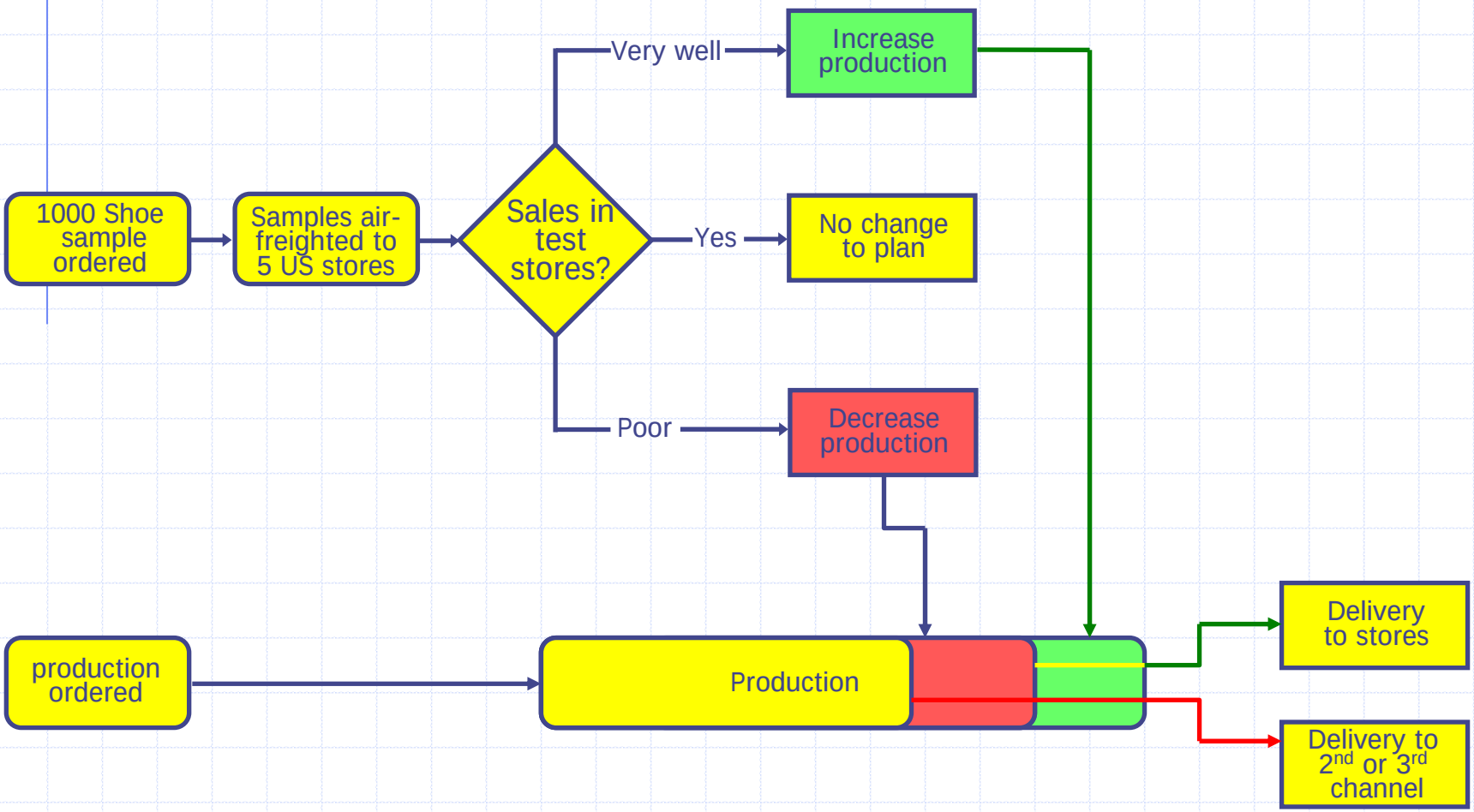
Nine West Offerings

- Nine West InCrowd $64.95
- Nine West Alsina $66.95

Traditional Supply Chain



Improved Supply Chain



Any Questions?

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