TURKISH AVIATION ACADEMY

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Forecasting and Risk Management

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M.Sc. Program

Logistic Management in Air Transport

Module 9

18 December 2015

Learning Objectives

- Understand the following concepts:

FORECASTING

Why do we forecast? | **How do we forecast?** | **What is a good forecast?**

RISK MANAGEMENT

Risk Identification | **Risk Estimation** | **Risk Evaluation**

Strategies: Allocating Risk/Risk Pooling

DID YOU KNOW?

- Predicting (forecasting) the weather plays an enormous role in the world of advertising and marketing
- In the world of marketing, retailers have always had a fundamental knowledge of weather because they had to navigate conditions to transport products from manufacturing plants to retail locations.
  - **"Sears spotted a pattern in their auto parts department. They realized that car batteries more than five years old tend to die after three consecutive nights of sub-zero temperatures - so they began to place ads on *the day after the third freeze*"**

WEATHER INFLUENCES ADVERTISING WHICH INFLUENCES DEMAND & LOGISTICS

- By crunching data and sales results from hundreds of categories, the *Weather Channel* has the ability to spot patterns.
  - **For example**, it learned that bug repellent sells well in Dallas during the spring when there was a below-average dew point (the temperature at which dew begins to form) - but in Boston bug repellent only sells when the dew-point is *above* average.
  - The Weather Channel **discovered** that the first day of above-average heat in Chicago results in a surge of air-conditioner sales. But in Atlanta, people will sweat it out for two days before making the *same run* to the appliance store.

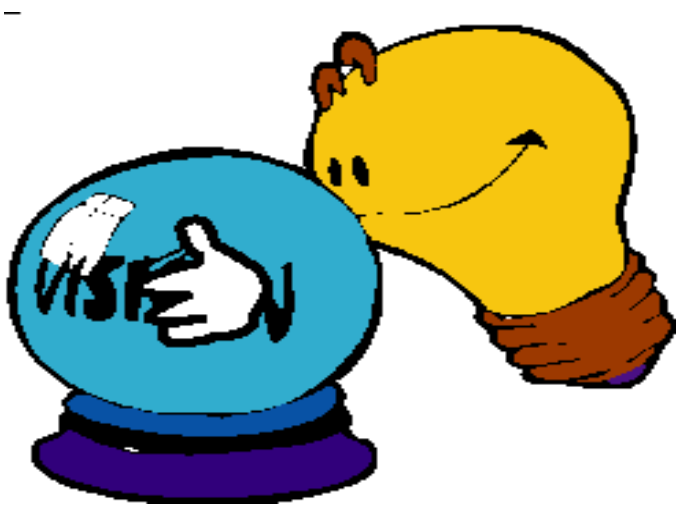
The fascinating "Profit of One Degree" list.

Source: wxtrends.com

- when the temperature drops one degree colder - soup sales go up 2%.
- When the temp goes up one degree - beer and soft drink sales go up 1.2%.
- *One degree colder* in the fall equals a 4% increase in children's apparel sales.
- *Just one degree hotter* in summer translates to a 10% increase in sun care products.
- *Just one degree colder* in the fall means a 25% increase in mousetrap sales.
- *And just one degree hotter* in summer - *just one degree* - results in a 24% increase for air conditioners.

What is Forecasting?

- A ‘statistical’ estimate of future demand, that can be used to plan current activities
- Often based on past sales (activity), while considering issues like seasonality, trends in demand, etc



Operations and Information @Wal-Mart

- Wal-Mart manages one of the world's largest data warehouses
- Wal-Mart tracks sales, inventory, shipment for each product at each store
  - Wal-Mart's demand forecasting system tracks 100,000 products, and predicts which products will be needed in each store
- The data warehouse is made available to store managers and suppliers

FORECASTING IS VITAL

Finance and Accounting:
Forecasts provide the basis for budgetary planning and cost control

Marketing
Relies on sales forecasting to plan new products and promotions

Production and Operations
Use forecasts to make decisions involving capacity planning, process selection and inventory control

Strategic Planning:
Forecasting is one of the basis for corporate long-run planning

Forecasting is Hard : Some Famous Forecasts

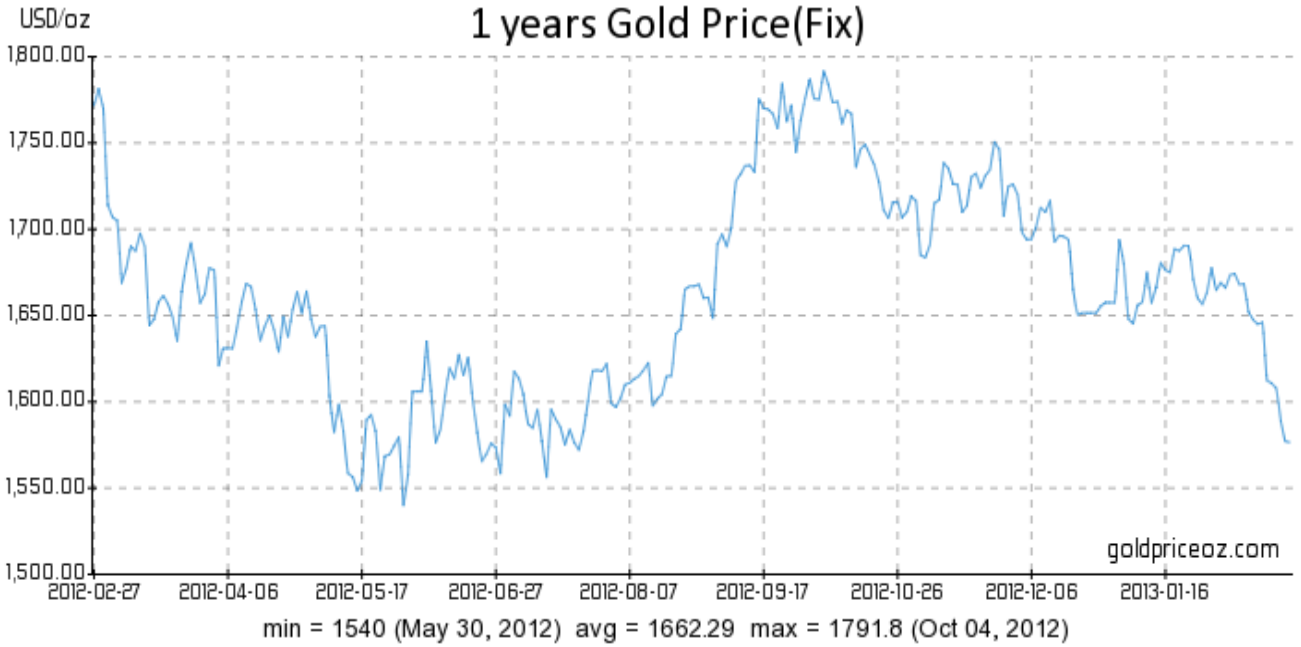
This "telephone" has too many shortcomings to be seriously considered as a means of communication. The device is inherently no value to us.
(Western Union internal memo, 1876)

The wireless music box has no imaginable commercial value. Who would pay for a message sent to nobody in particular?
(David Sarnoff's associates in response to his urgings for investment in the radio in the 1920s)

I think there is a world market for maybe five computers.
(Thomas Watson, chairman of IBM, 1943)

There is no reason anyone would want a computer in their home.
(Ken Olson, President, chairman and founder of DEC, 1977)

INVESTING IN GOLD?



FORECAST FOR 2010?

Year	Data
1998	4
1999	22
2000	38
2001	20
2002	20
2003	31
2004	31
2005	22
2006	57
2007	71
2008	61
2009	60
2010	???

How do we forecast? Example 1

- You are working for BIM
- Your first assignment

> Determine the number of units of the latest iPad model to order for Christmas sales

- How would you approach this problem?

How do we forecast? *Qualitative* Methods

Executive Judgment
Based on experience and history

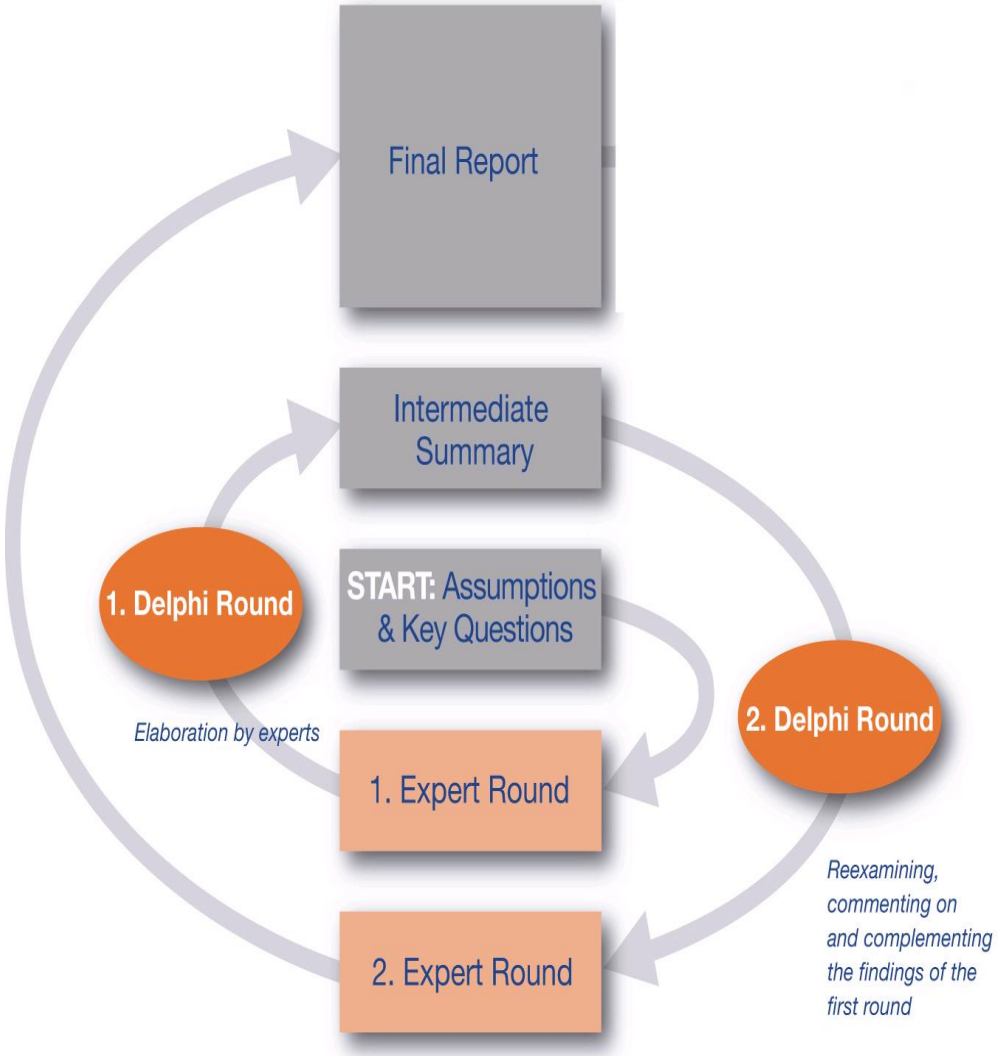
Market Research
Surveys, interviews, etc

Panel Consensus
Meetings of executives, salespeople and customers

Delphi Method

1. Choose experts to participate representing a variety of points of view
2. Obtain forecasts (and reasoning) from all participants
3. Summarize the results and redistribute them to the participants along with appropriate new questions
4. Summarize again, refining forecasts and conditions, and again develop new questions to distribute to all participants
5. Repeat the previous step as necessary and distribute the final results.

ILLUSTRATION OF DELPHI PROCESS



How do we forecast? Example 2

- You are working for Makro
- Your first assignment

> Determine the number of units of bread to order for next week's sales

- How would you approach this problem?
- What about unit of whole wheat bread? How is this a different problem?

How do we forecast?
Quantitative Methods

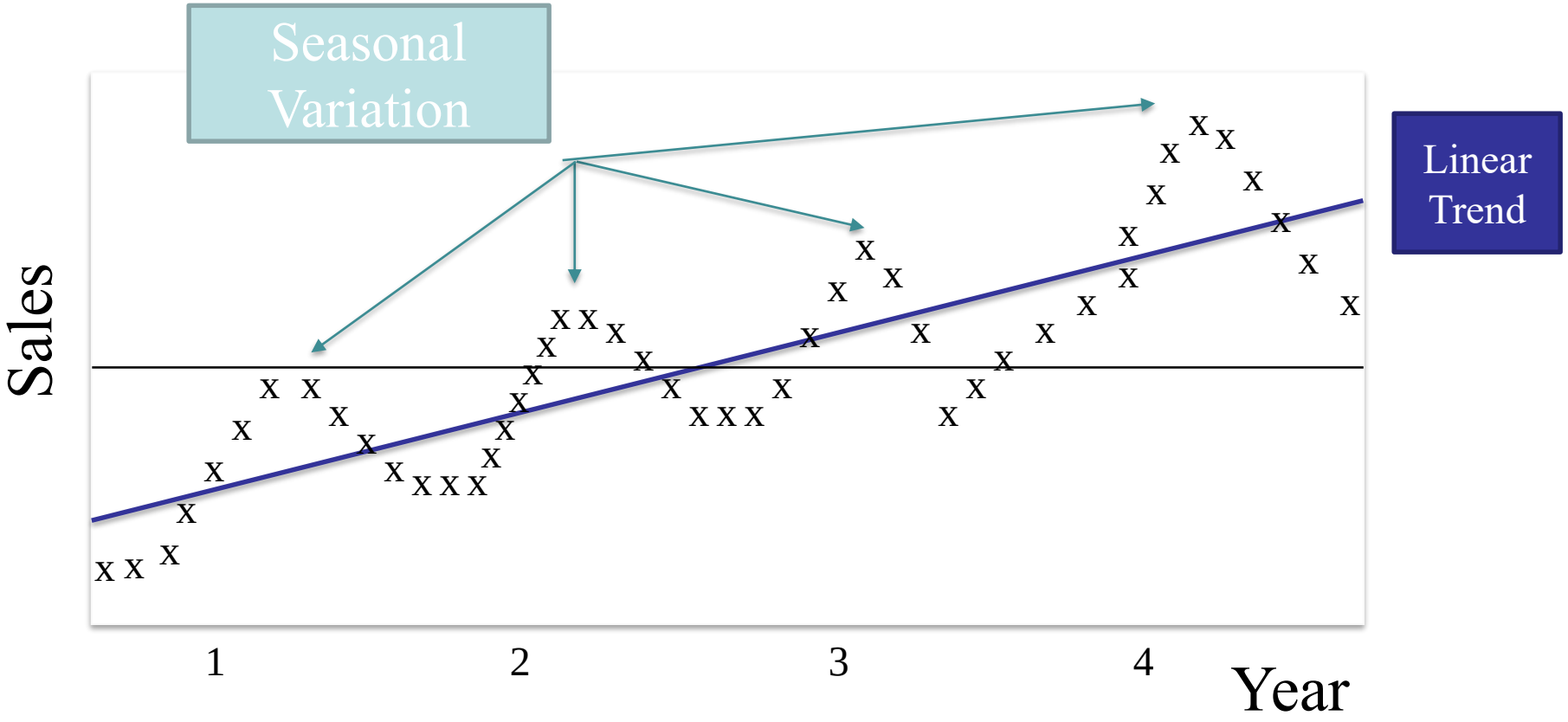
Time Series Analysis

Times series forecasting models try to predict future based on past data

Some common approaches

- Moving averages
- Exponential smoothing

A Typical Time-Series of Past Demands



Simple Moving Average: Example

Week	Demand
1	650
2	678
3	720
4	785
5	859
6	920
7	850
8	758
9	892
10	920
11	789
12	844

The average can be taken over a number of weeks of previous data

$$F_t = \frac{A_{t-1} + A_{t-2} + A_{t-3} + \cdots + A_{t-n}}{n}$$

n-period moving average forecast for period t

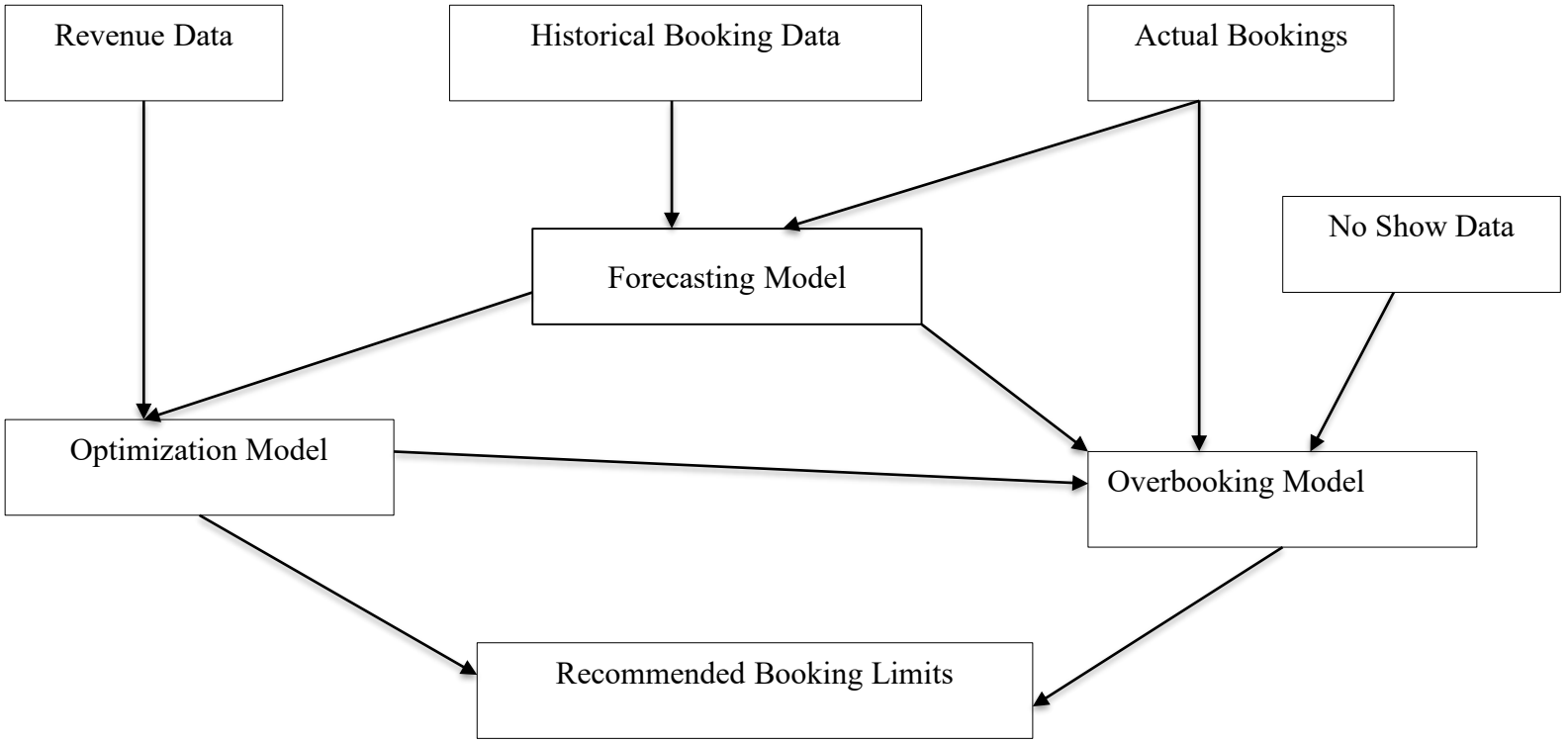
Simple Moving Average: Example

Week	Demand	3-Week Moving Average Forecast	6-Week Moving Average Forecast
1	650	N/A	N/A
2	678	N/A	
3	720	N/A	
4	785	682.67	N/A
5	859	727.67	
6	920	780.00	
7	850	854.67	768.67
8	758	876.33	802.00
9	892	842.67	815.33

$F_4=(650+678+720)/3$
$=682.67$

$F_7=(650+678+720+785+859+920)/6$
$=768.67$

EXAMPLE OF FORECASTING IN REVENUE MANAGEMENT MODELS



PICKUP OR STANDARD FORECASTING

Pickup or Standard Forecasting

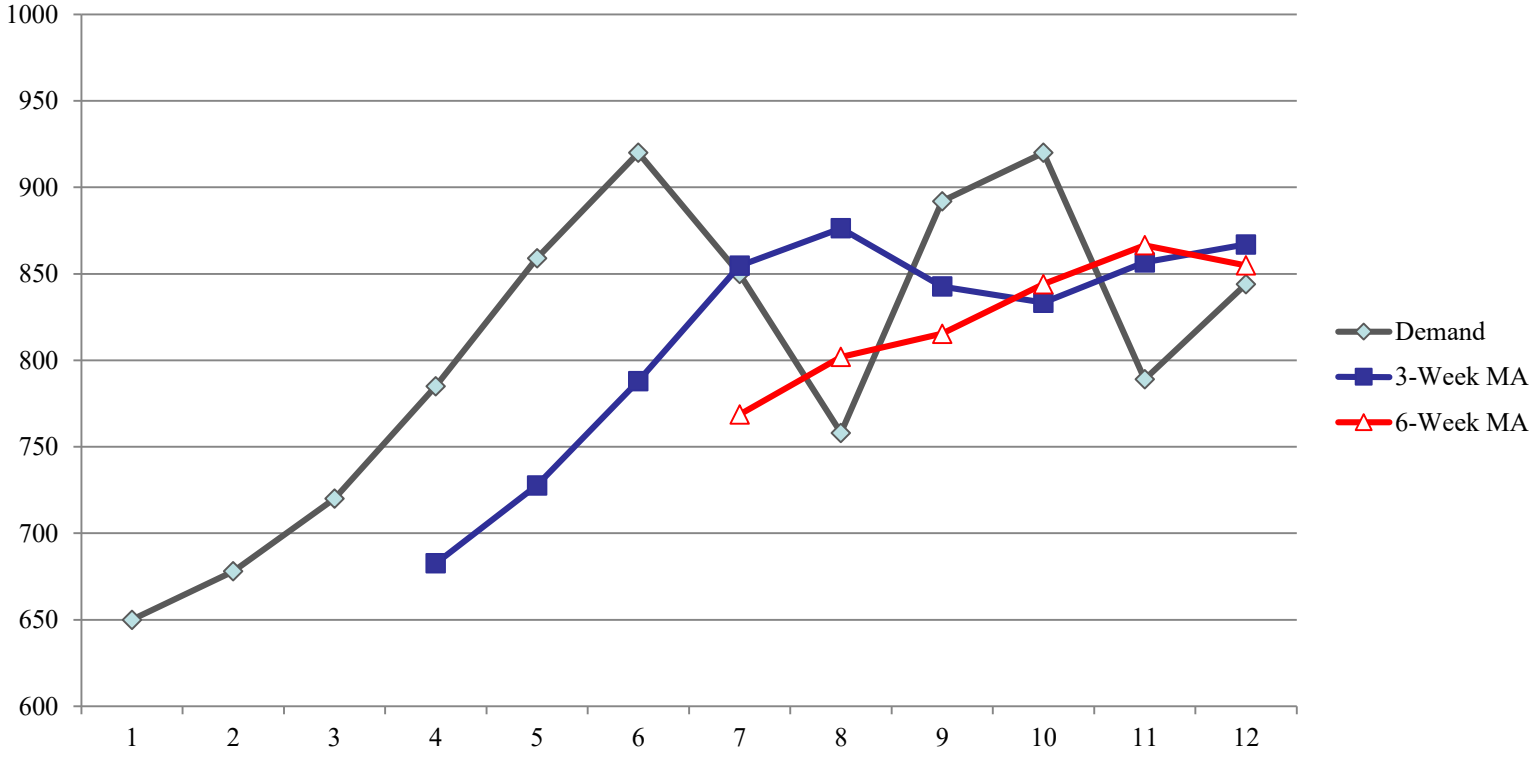
-3 Days	-2 Days	-1 Day	0 Days	Flight Date	Booking in Hand	Bookings to Come
8	13	3	13	09-Jan	37	0
11	5	4	2	10-Jan	22	0
6	2	6	8	today	22	0
6	3	2	7.67	12-Jan	11	7.67
1	2	3.75	7.67	13-Jan	3	11.42
4	5	3.75	7.67	14-Jan	4	16.42

=(13+2+8)/3

Forecast for Jan 12th is mean of bookings of previous 3 days

Bookings to come forecast is simply the sum of the forecasts for days of bookings remaining for a particualr flight in the future

PLOTTING THE MOVING AVERAGES



- Which is a better forecast?
- How many past weeks should we consider?

WHAT IS A *GOOD* FORECAST?

$$\text{forecast error} = \text{forecast value} - \text{actual value}$$
$$= F_t - A_t$$

- The smaller the errors, the better the forecast
- One approach is to evaluate a forecast method is to compute the **mean absolute deviation**:

$$MAD = \frac{\sum_{t=1}^{n} |F_t - A_t|}{n}$$

Why not just MEAN deviation?

What is the ideal MAD?

Sold Out Newsvendor example

What does a high MAD indicate?

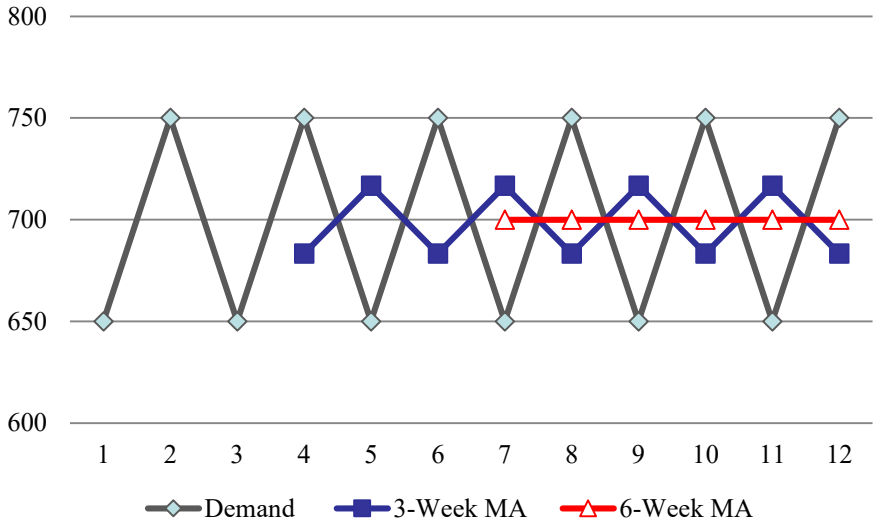
CALCULATING THE MAD

- Using some forecasting method, you have the following forecasts. What is the MAD?

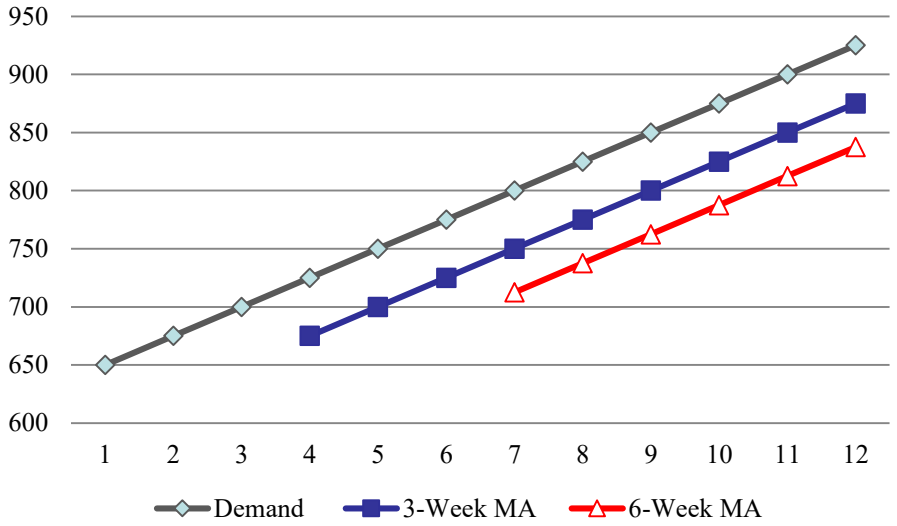
Month	Demand	Forecast
1	220	
2	250	255
3	210	205
4	300	320
5	325	315

$$MAD =$$

WHICH FORECAST HAS THE LOWER MAD?



The 6-week moving average has a lower error



The 3-week moving average has a lower error

TESTING THE ROBUSTNESS OF A FORECAST: THE TRACKING SIGNAL

Month	Demand Forecast	Actual	Deviation	RSFE	ABS Deviation	Sum of ABS Deviation	Mean ABS Deviation	TS=RFSE/MAD
1	1000	950	-50	-50	50	50	50.00	-1.00
2	1000	1070	70	20	70	120	60.00	0.33
3	1000	1100	100	120	100	220	73.33	1.64
4	1000	960	-40	80	40	260	65.00	1.23
5	1000	1090	90	170	90	350	70.00	2.43
6	1000	1050	50	220	50	400	66.67	3.30

The *running sum of forecast errors* (RSFE) considers the nature of the error.

***Tracking signal* is a measure that indicates whether the forecast average is keeping pace with any genuine upward or downward changes in demand.**

How many periods should be used?

Advantages of More Periods

- More data points give a better estimate
- The effect of randomness is reduced by averaging together a number of observations
- When there is no trend in the data, using more observations results in a forecast with lower error

Disadvantages of More Periods

- A large number of observations will cause the moving average to respond slowly to permanent changes
- When there is a trend in the data, using more observations results in a forecast with high error

Other Ways of Introducing Trend

- **Weighted Moving Average**
  - Place a greater weight on more recent observations

$$F_t = w_1 \cdot A_{t-1} + w_2 \cdot A_{t-2} + w_3 \cdot A_{t-3} + \cdots + w_n \cdot A_{t-n}$$

W_k = Weight given to the period that is k periods ago
(Weights must add to one)

$$w_1 + w_2 + \cdots + w_n = 1$$

- **Exponential Smoothing** (very common)

EXPONENTIAL SMOOTHING

$$F_t = F_{t-1} + \alpha \cdot (A_{t-1} - F_{t-1}) \quad \text{or} \quad F_t = \alpha \cdot A_{t-1} + (1-\alpha) \cdot F_{t-1}$$

$\mathbf{F_t}$	Forecast for period t
$\mathbf{F_{t-1}}$	Forecast for period t-1
$\mathbf{A_{t-1}}$	Actual demand in period t-1
$\boldsymbol{\alpha}$	Parameter (between 0 and 1)

More recent observations are given more weight

Linear Regression Analysis

- *Regression* is defined as a functional relationship between two or more correlated variables.
- *Linear regression forecasting* refers to a forecasting technique that assumes that past data and future projections fall around a straight line.

Linear Regression Analysis

The simple linear regression model seeks to fit a line through various data over time

Is the regression model rally linear?

$$Y_t = a + bx + \varepsilon$$

Y_t is the regressed forecast value or dependent variable in the model, a is the intercept value (constant) of the the regression line, and b is the slope of the regression line.

Forecast: $\Delta Y/\Delta x = b$

Linear Regression Analysis

$$a = \bar{y} - b\bar{x}$$

$$b = \frac{\sum xy - n(\bar{y})(\bar{x})}{\sum x^2 - n(\bar{x})^2}$$

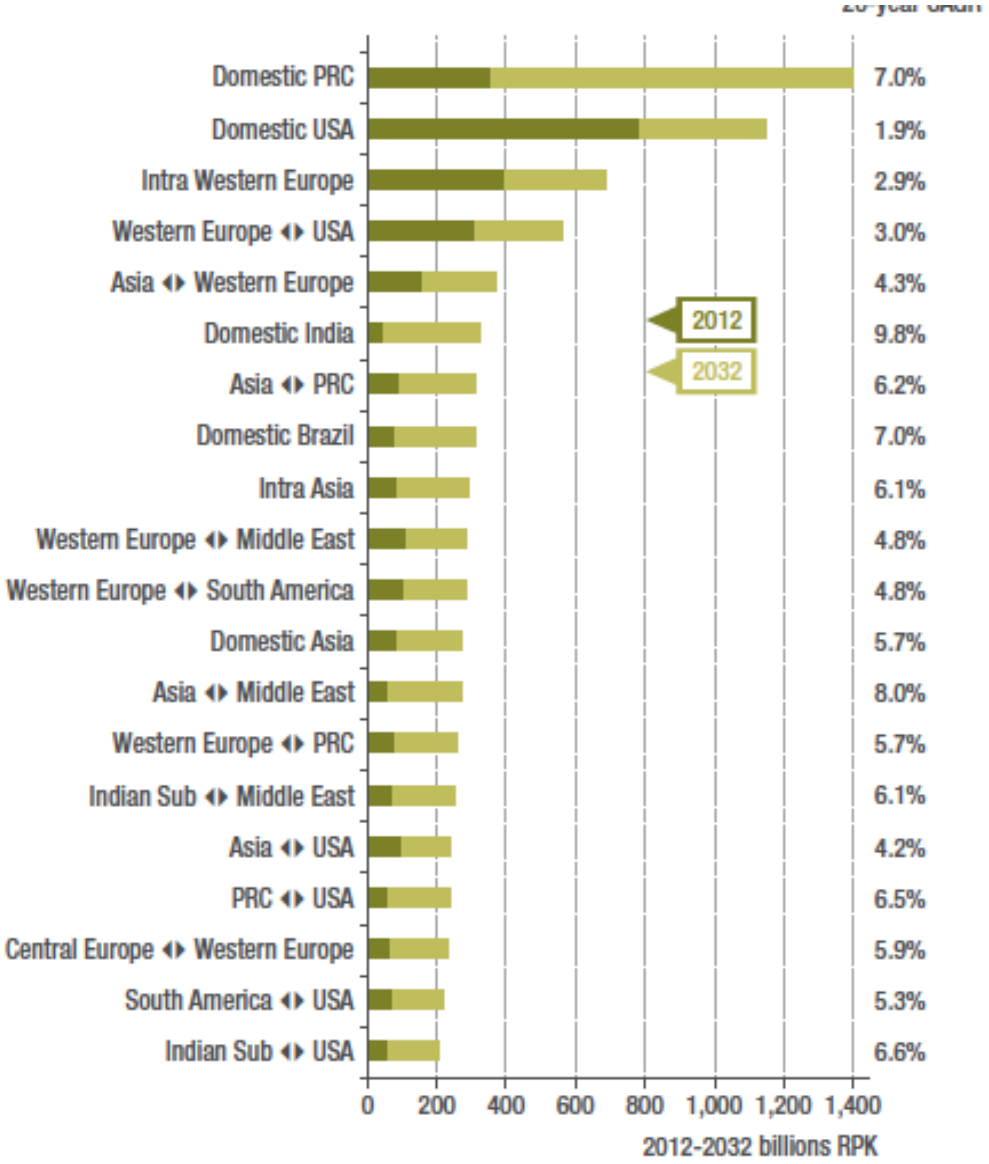
EXAMPLES OF FORECASTS: AIRBUS & BOEING

	Africa	Europe	Middle East	North America	Central America	South America	South Asia	Southeast Asia	Northeast Asia	Oceania	China
Africa	6.3	4.8	7.5	5.8				6.7			
Europe		3.6	5.0	3.5	4.5	4.8	7.2	5.0	3.2		6.1
Middle East			5.7	6.4			7.5	6.6			
North America				2.3	4.2	6.1		6.5	2.2	4.2	6.3
CentralAmerica					4.6	6.5					
South America						7.5					
South Asia									4.9		
Southeast Asia								8.4		5.1	7.5
Northeast Asia									2.5	3.5	4.8
Oceania										4.5	6.4
China											6.9

AIRBUS: BASIS FOR ITS MARKET AND REGIONAL FORECASTS

- view of the key economic and operational drivers of air transport markets in the next 20 years
  - Growth in GDP=C+I+G+(X-M)
  - Urbanization (↑ urbanization leads to ↑ pax traffic)
  - Growth of middle class
  - Long term rise in oil prices
  - Growth in route development
  - Fares
  - Emerging economies

AIRBUS 20 YEAR FORECAST



ONCE YOU HAVE A FORECAST, HOW DO YOU USE THIS INFORMATION?

You forecast that the latest model of the iPod will sell 100 units.

Is this a good forecast?

Do we order 100 units?

You forecast that the product will sell 100 units and the error in your forecast will be +/- 25 units.

How to use this information? (Will discuss in later classes)

You forecast defects using sampling techniques in total quality management

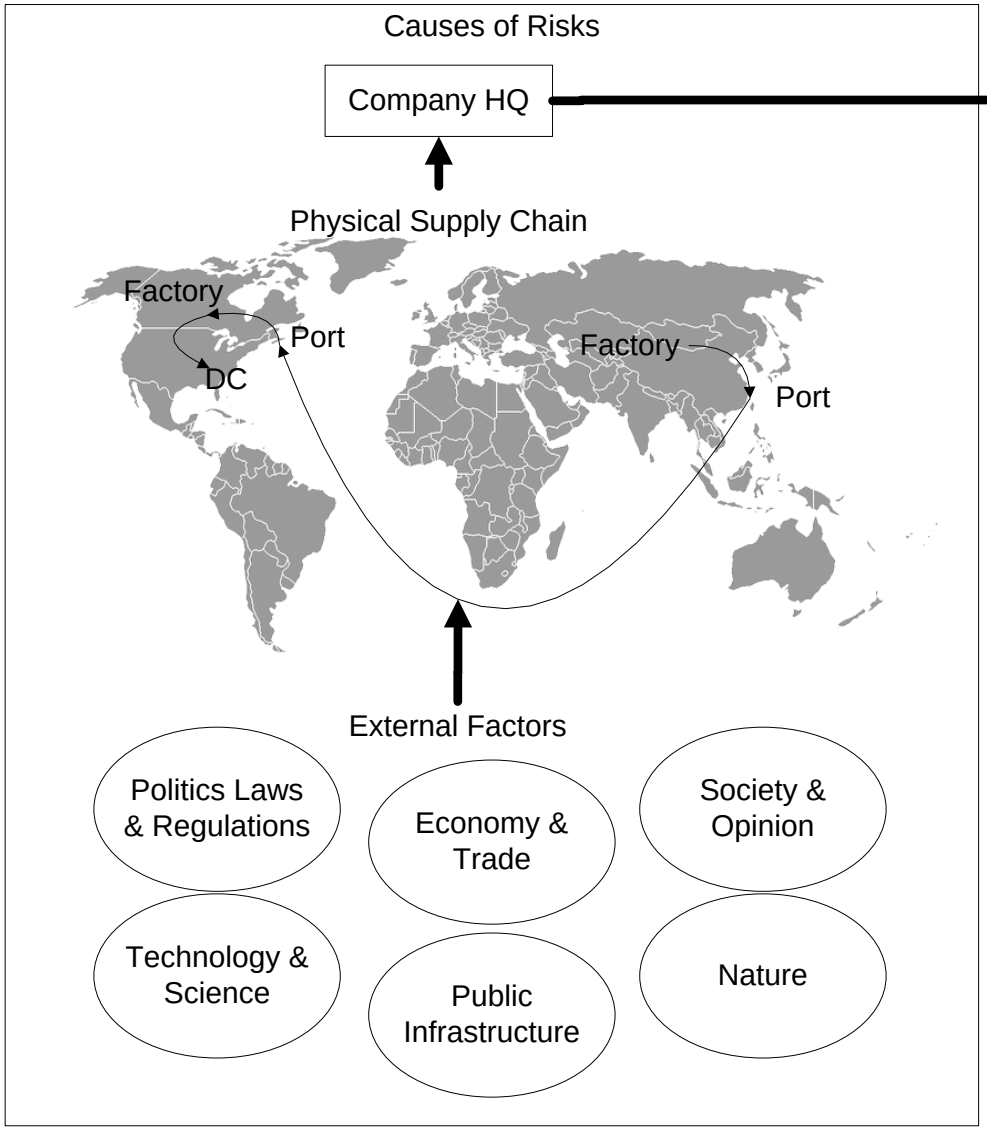
Forecasting Tips

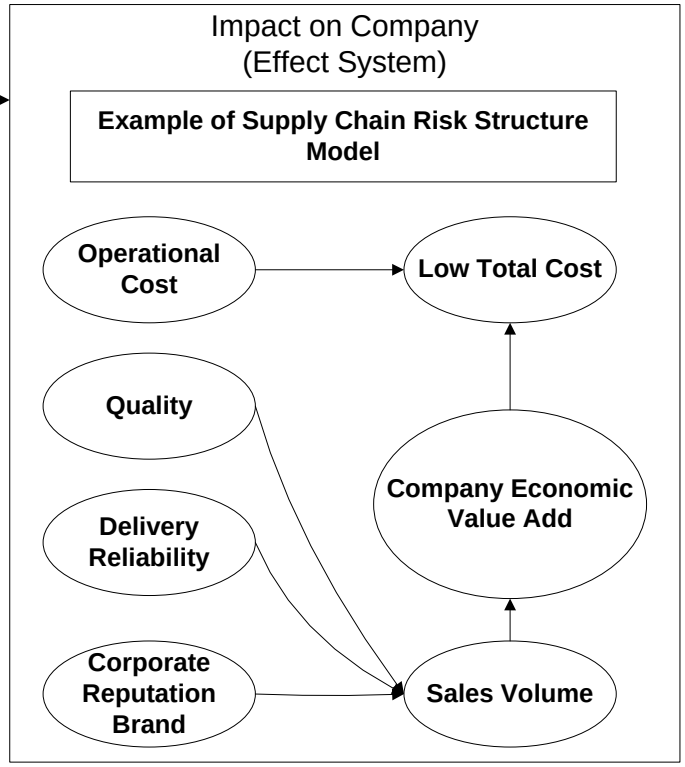
- Plot the data to get a sense of how it works

1	Forecasts are always wrong A good forecast should include some information about its error
2	Long-term forecasts are less accurate than short-term forecasts
3	Aggregate forecasts are more accurate than disaggregate forecasts Why?

RISK MANAGEMENT

Supply Chain Risk Structure





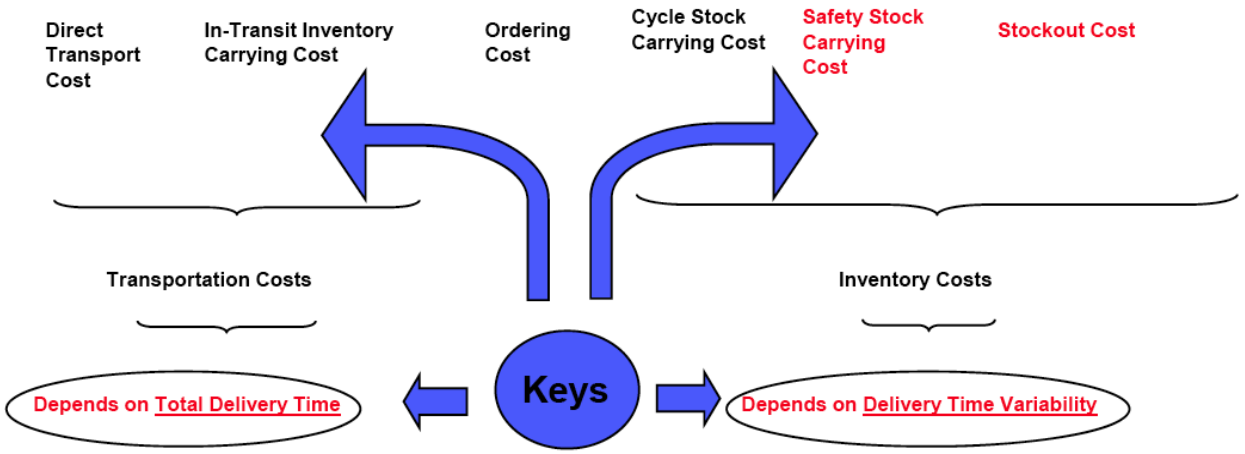
Risk Management

- Identification-what can go wrong
- Estimation- consequences
- Evaluation-mitigation
- Allocation
  - Pooling strategies
  - Efficient contracts

FRAMEWORK: TOTAL LOGISTICS COST FUNCTION

Total Logistics Cost Model

$$TLC = RD + (UCTD/365) + SD/Q + QCI/2 + rIC + K(D/Q)N(Z)S`$$

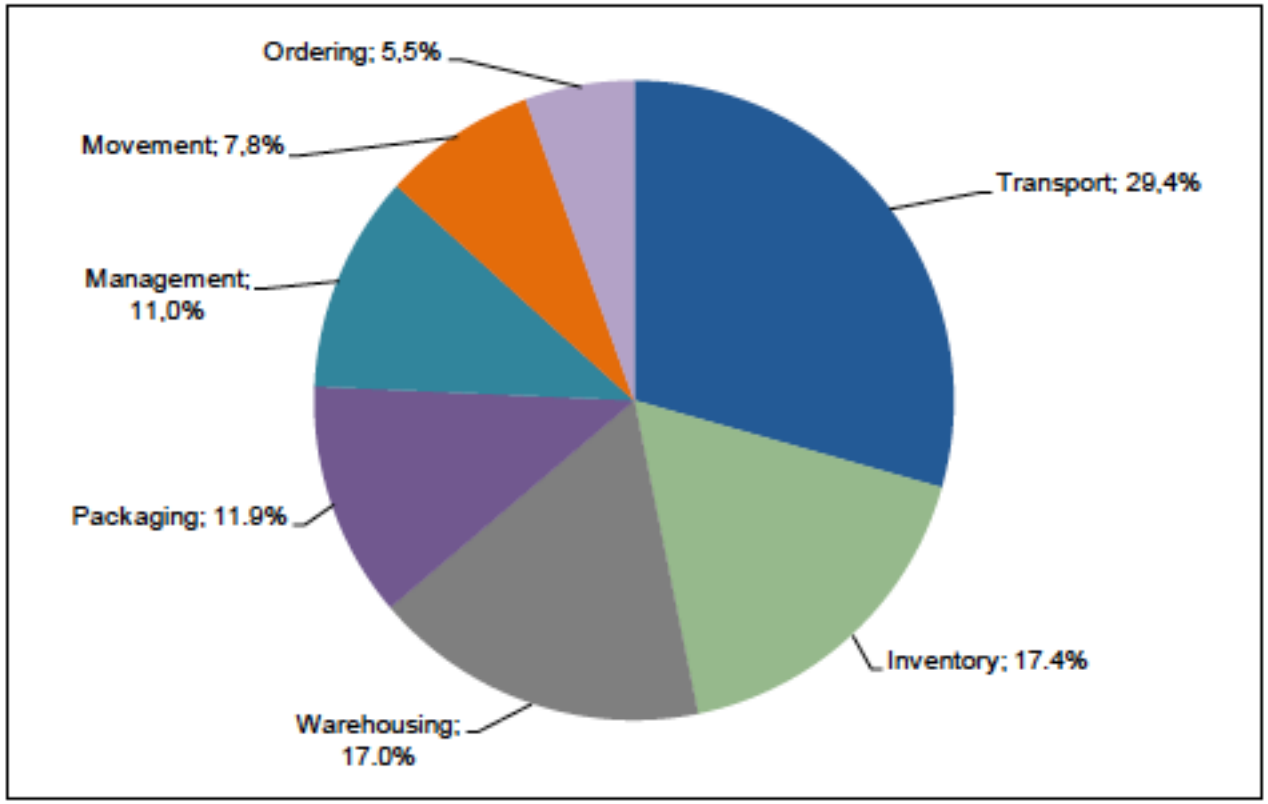


COMPONENTS OF TLC

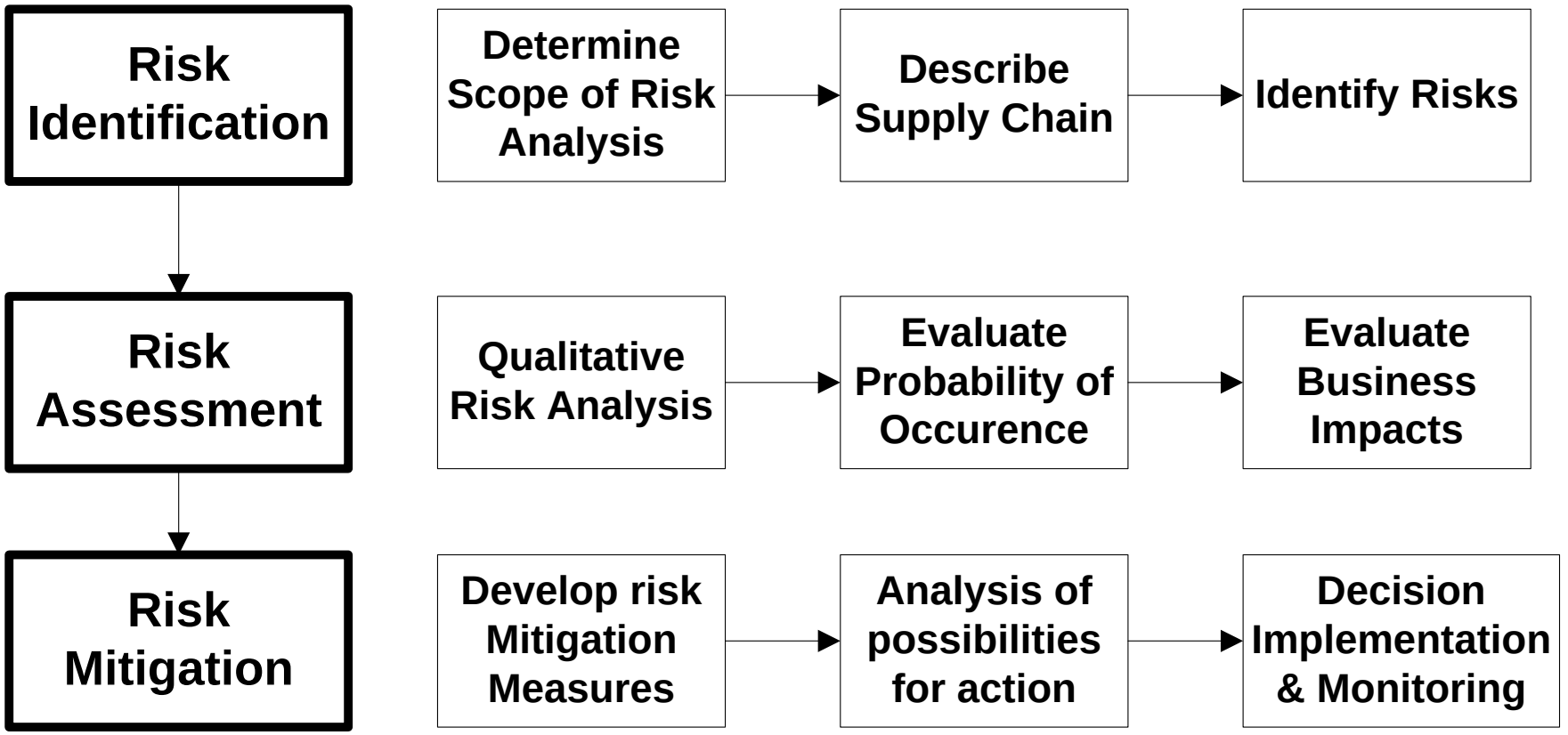
$$TLC\ (Q, r: T, S_T) = RD_i + (UCTD_i/365) + (SD_i/Q) + (QCI/2) + rIC + K(D_i/Q)\ N(Z)S^l$$

where:
TLC = total logistics cost
R = Transportation Rate per Unit between Origin and Destination
D = Annual Demand for some good 'i'
U = Carrying Cost of In-transit Inventory
C = Value per Unit
T = Transit Time of Transportation Alternative
S = Fixed Ordering Cost per Order
Q = Order Quantity
I = Carrying Cost of Warehoused Inventory
r = Safety Stock
K = Stockout Cost per Unit
N(Z) = Unit Loss Integral
S^l = Standard Deviation of Demand During Transit Time
S_T = Standard Deviation of Demand During Lead Time

How these Costs are Distributed



Supply Chain Risk Management Process



Risk Management

- **Mitigating Risk**
  - Reducing the likelihood an adverse event will occur
  - Reducing impact of adverse event
- Transferring Risk
  - Paying a premium to pass the risk to another party
- Avoiding Risk
  - Changing the event to eliminate the risk or condition
- **Sharing Risk**
  - Allocating risk to different parties
- Retaining Risk
  - Making a conscious decision to accept the risk

Mitigating Risk

– Managing an event, Project or Contract

Sharing Risk

– risk allocation and Pooling

Risk pooling strategies to reduce and hedge uncertainty – to manage risk

RISK POOLING STRATEGIES

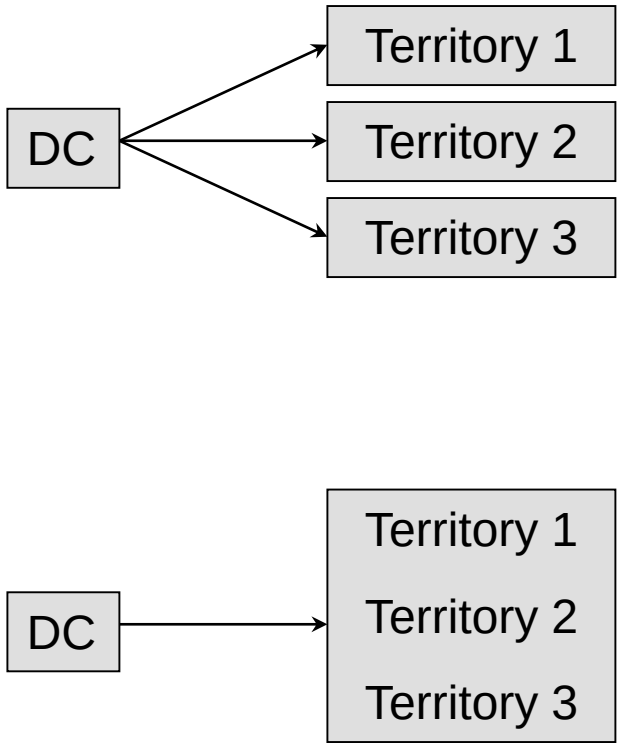
- The objective of a risk pooling strategy is to redesign the supply chain, the production process or the product to either reduce the uncertainty the firm faces or to hedge uncertainty so that the firm is in a better position to mitigate the consequence of uncertainty.
- Four versions of risking pooling:
  - location pooling
  - product pooling
  - lead time pooling
    - delayed differentiation (HP case)
    - consolidated distribution
  - capacity pooling

RISK POOLING STRATEGIES:

LOCATION POOLING

Location pooling at Medtronic

- Current operations:
  - Each sales representative has her own inventory to serve demand in her own territory.
  - Lead time is 1 day from DC (Distribution Center)
  - e.g., 3 territories, 3 stockpiles of inventory
- The location pooling strategy:
  - A single location stores inventory used by several sales reps.
  - Sales reps no longer hold their own inventory, they must pull inventory from the pooled location.
  - Inventory is automatically replenished at the pooled location as depleted by demand.
  - Lead time to pooled location is still 1 day from DC.
  - e.g., 3 pooled territories, 1 stockpile of inventory



THE IMPACT OF LOCATION POOLING ON INVENTORY

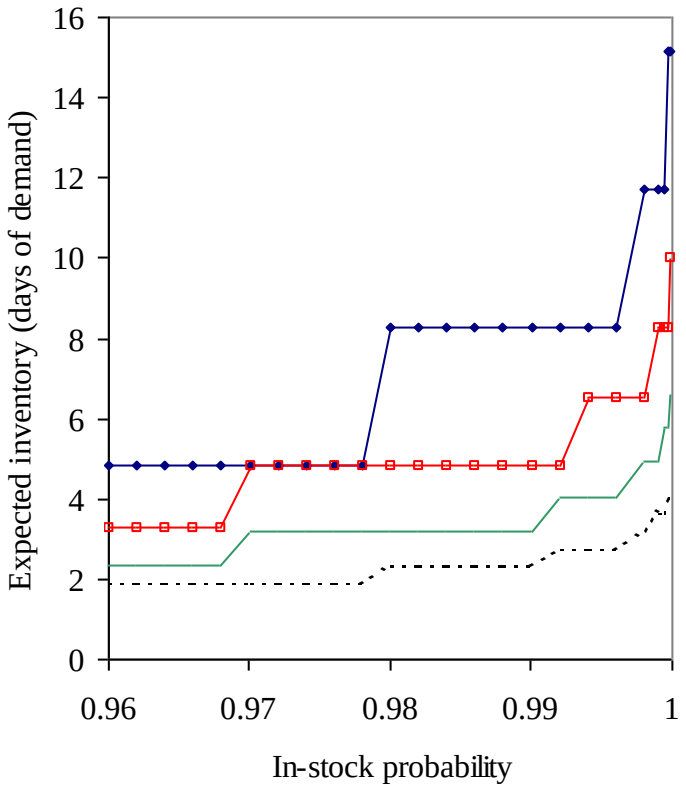
- Suppose each territory's expected daily demand is 0.29, the required in-stock probability is 99.9% and the lead time is 1 day with individual territories or pooled territories.

			Expected inventory		Pipeline inventory	
Number of territories pooled	Pooled territory's expected demand per day (a)	S	units (b)	days-of-demand (b/a)	units (c)	days-of-demand (c/a)
1	0.29	4	3.4	11.7	0.29	1.0
2	0.58	6	4.8	8.3	0.58	1.0
3	0.87	7	5.3	6.1	0.87	1.0
4	1.16	8	5.7	4.9	1.16	1.0
5	1.45	9	6.1	4.2	1.45	1.0
6	1.74	10	6.5	3.7	1.74	1.0
7	2.03	12	7.9	3.9	2.03	1.0
8	2.32	13	8.4	3.6	2.32	1.0

- Pooling 8 territories reduces expected inventory from 11.7 days-of-demand down to 3.6.
- But pooling has no impact on pipeline inventory.

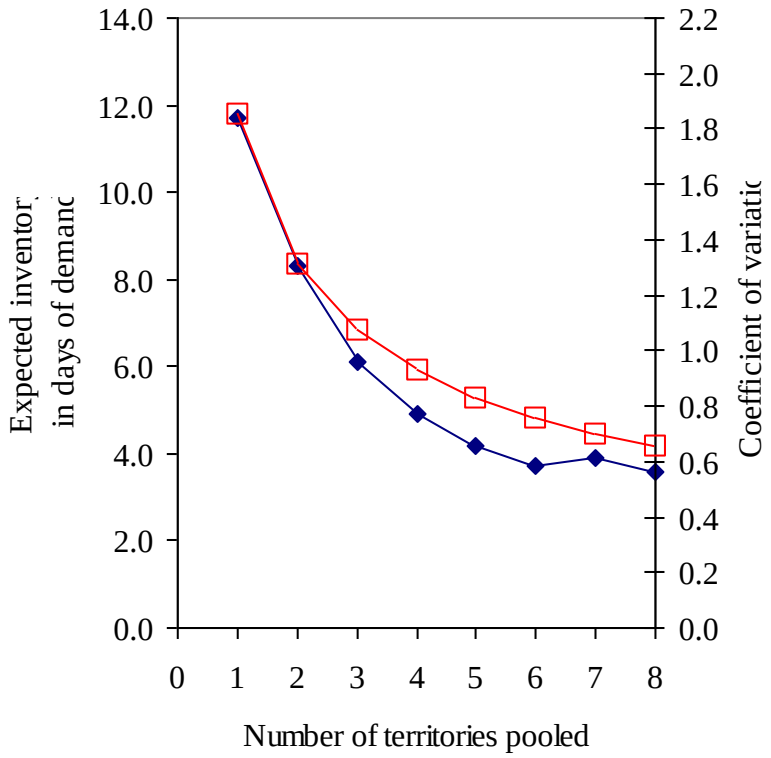
LOCATION POOLING AND THE INVENTORY-SERVICE TRADEOFF CURVE

- Location pooling shifts the inventory-service tradeoff curve down and to the right.
- For a single product, location pooling can be used to decrease inventory while holding service constant, or increase service while holding inventory cost, or a combination of inventory reduction and service increase.
- Or location pooling can be used to broaden the product line.



WHY DOES LOCATION POOLING WORK?

- Location pooling reduces demand uncertainty as measured with the coefficient of variation.
- Reduced demand uncertainty reduces the inventory needed to achieve a target service level
- But there are declining marginal returns to risk pooling!
  - Most of the benefit can be captured by pooling only a few territories.



LOCATION POOLING PROS, CONS AND ALTERNATIVES

- Pros:
  - Reduces demand uncertainty which allows a firm to reduce inventory, increase service, expand the product line, or a combination of all three.
- Cons:
  - Location pooling moves inventory away from customers:
    - This creates an inconvenience for the sales reps.
    - May create costs to ship product to customers, but may reduce inbound transportation because of consolidation.
- Alternatives:
  - Virtual pooling:
    - Each rep keeps her own inventory, but shares inventory with nearby reps if needed.
  - Drop shipping:
    - If a firm doesn't have enough demand at each location to justify holding inventory, the firm can location pool with other firms via a drop shipping firm, e.g., Alliance Entertainment holds inventory and performs fulfillment for Circuit City's online DVD store.

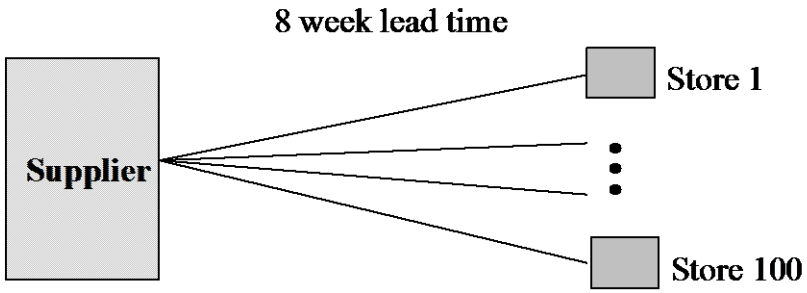
RISK POOLING STRATEGIES:

LEAD TIME POOLING

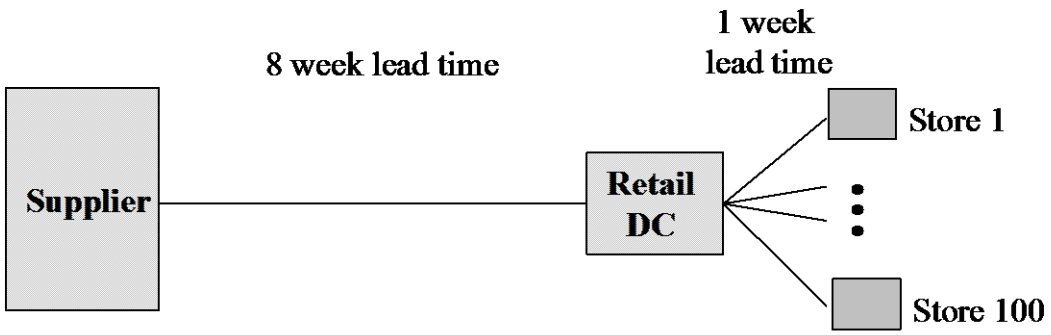
Lead time pooling – consolidated distribution

- Consider the following two systems:
  - In each case weekly demand at each store is Poisson with mean 0.5 and the target in-stock probability at each store is 99.5%

Current system: direct from supplier



Proposed system: centralized inventory in a distribution center



DC demand is normally distributed with mean 50 and standard deviation 15

If demands were independent across stores, then DC demand would have a standard deviation of sqrt(50) = 7.07

CONSOLIDATED DISTRIBUTION RESULTS

	Direct delivery supply chain	Centralized inventory supply chain	Location pooling
Expected total inventory at the stores	650	300	0
Expected inventory at the DC	0	116	116
Pipeline inventory between the DC and the stores	0	50	0
Total	650	466	116

- Consolidated distribution …
  - reduces retail inventory by more than 50%!
  - is not as effective at reducing inventory as location pooling…
  - reduces inventory even though the total lead time increases from 8 to 9 weeks!

CONSOLIDATED DISTRIBUTION SUMMARY

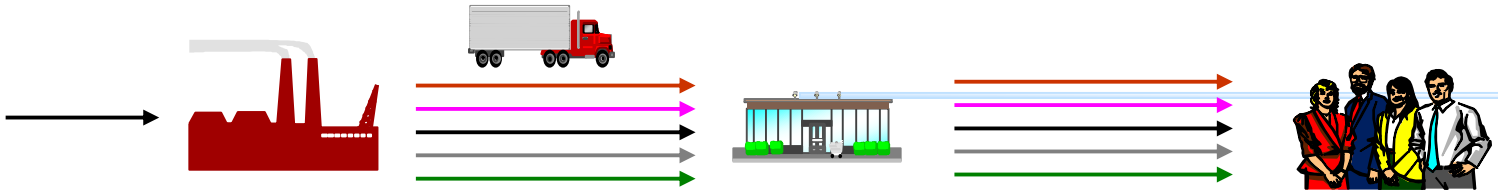
- Consolidated distribution reduces inventory in a supply chain via lead time risk pooling
  - Due to lead time risk pooling the supply chain only needs to decide the total quantity to ship from the supplier, not a total quantity and its allocation across locations. Hence, some uncertainty is avoided.
  - Most effective if demands are negatively correlated across locations.
  - Most effective if the supplier lead time is long and the DC to store lead time is short.
  - But consolidated distribution increases total distance traveled and total lead time from supplier to stores.
- Other benefits of consolidated distribution:
  - Easier to obtain quantity discounts in purchasing.
  - Easier to obtain economies of scale in transportation:

Lead time risk pooling – delayed differentiation

Example: airlines will have food trays with everything except the main course (we are speaking business class here!!), once the passenger selects a main course, it is provided

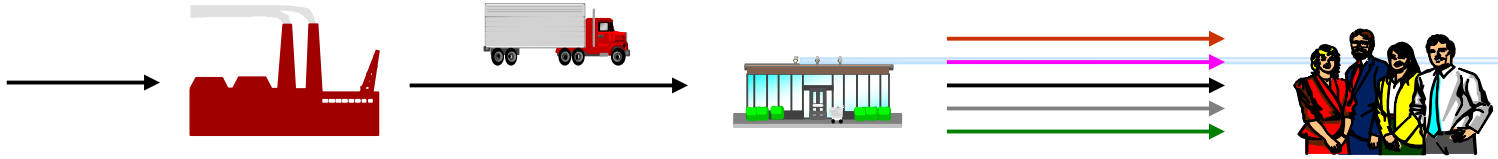
- When does delayed differentiation make sense:
  - Customers demand variety.
  - There is less uncertainty with total demand than demand for individual versions.
  - Variety is created late in the production process.
  - Variety can be added quickly and cheaply.
  - Components needed for variety are inexpensive relative to the generic component.

DELAYED DIFFERENTIATION WITH RETAIL PAINT



color pigments,
paint mixing,
packaging

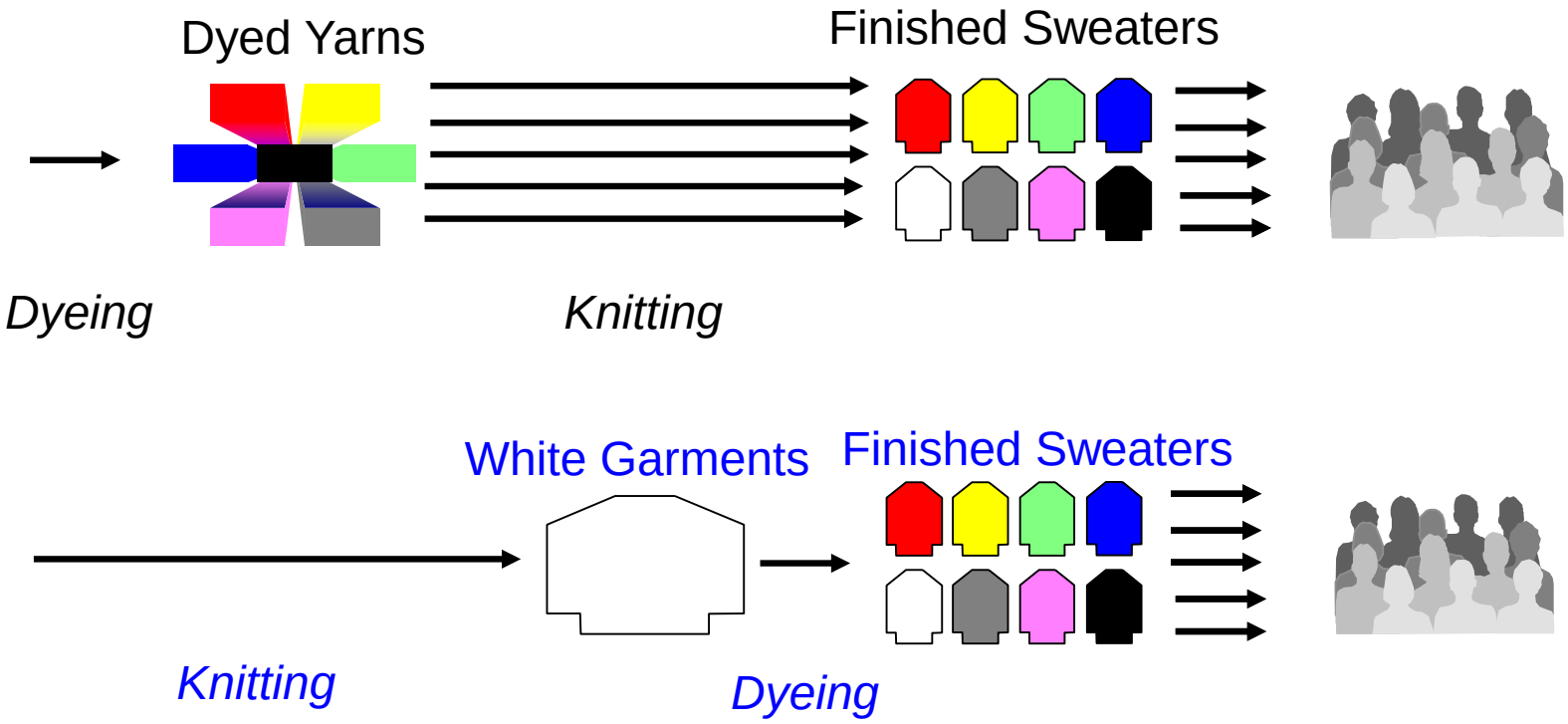
retail sales



color pigments

retail sales,
paint mixing,
packaging

Delayed differentiation with process re-sequencing at Benetton



OTHER EXAMPLES OF DELAYED DIFFERENTIATION

- Private label soup manufacturer:
  - Problem: many different private labels (Giant, Kroger, A&P, etc)
  - *Solution*: Hold inventory in cans without labels, add label only when demand is realized.
- Black and Decker:
  - Sell the same drill to different retailers that want different packaging.
  - Store drills and package only when demand is realized.
- Nokia:
  - Customers want different color phones.
  - Design the product so that color plates can be added quickly and locally.

RISK POOLING STRATEGIES:

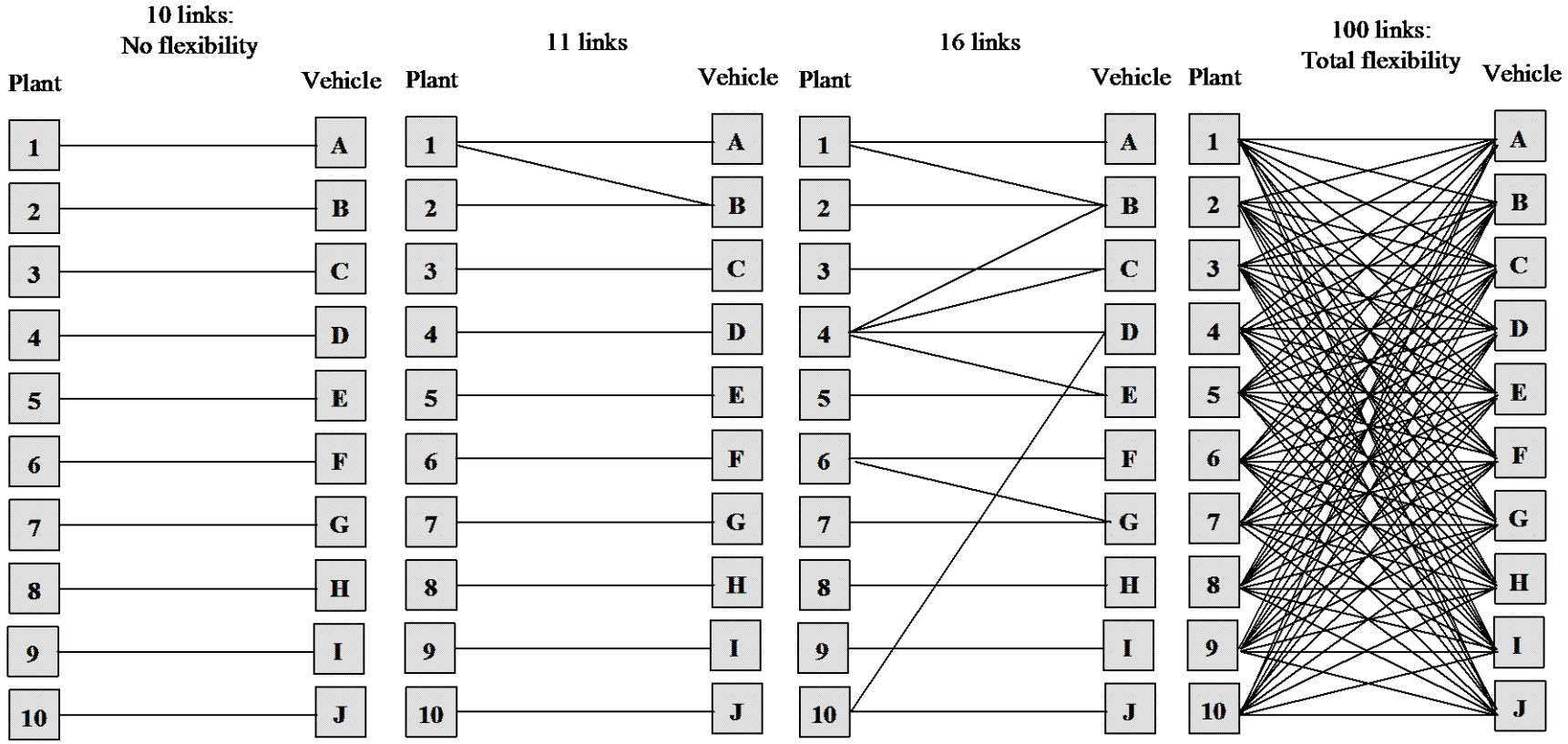
CAPACITY POOLING

CAPACITY POOLING WITH FLEXIBLE MANUFACTURING

- Consider the following stylized situation faced by GM …
  - They have 10 production facilities
  - They have 10 vehicles to produce (GMC truck, Chevy Tahoe, Buick Roadmaster, etc).
  - Each plant is capable of producing 100 units.
  - Demand for each product is Normally distributed with mean 100 and standard deviation 40.
  - Each plant can be configured to produce up to 10 products
  - But flexibility is expensive, i.e., the cost to construct a plant is increasing in the number of products it can produce.
  - GM must decide which plants can produce which products before demand is realized.
  - After demand is realized, GM can allocate its capacity to satisfy demand.
  - If demand exceeds capacity, sales are lost.

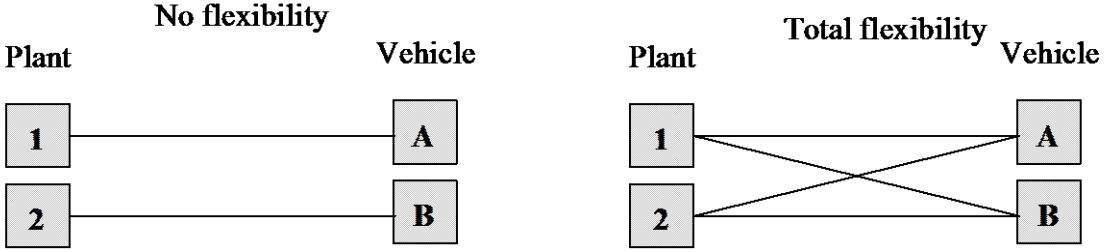
FOUR POSSIBLE CAPACITY CONFIGURATIONS: NO FLEXIBILITY TO TOTAL FLEXIBILITY

- The more links in the configuration, the more flexibility constructed
- In the 16 link configuration plant 4 is flexible enough to produce 4 products but plant 5 has no flexibility (it produces a single product).



How is flexibility used

- Flexibility allows production shifts to high selling products to avoid lost sales.
- Consider a two plant, two product example and two configurations, no flexibility and total flexibility:



- If demand turns out to be 75 for product A, 115 for product B then..

With no flexibility

Product	Demand	Production Plant 1	Production Plant 2	Sales
A	75	75	0	75
B	115	0	100	100

Total Sales	175
Plant Utilization	88%

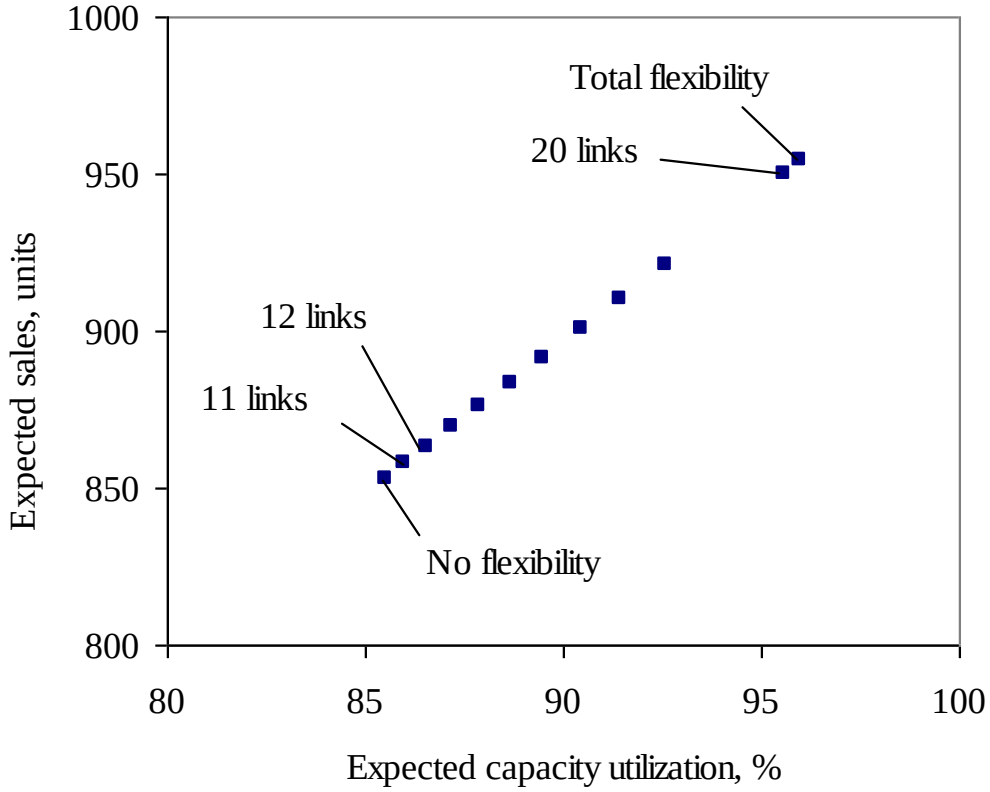
With total flexibility

Product	Demand	Production Plant 1	Production Plant 2	Sales
A	75	75	0	75
B	115	15	100	115

Total Sales	190
Plant Utilization	95%

THE VALUE OF FLEXIBILITY

- Adding flexibility increases capacity utilization and expected sales:



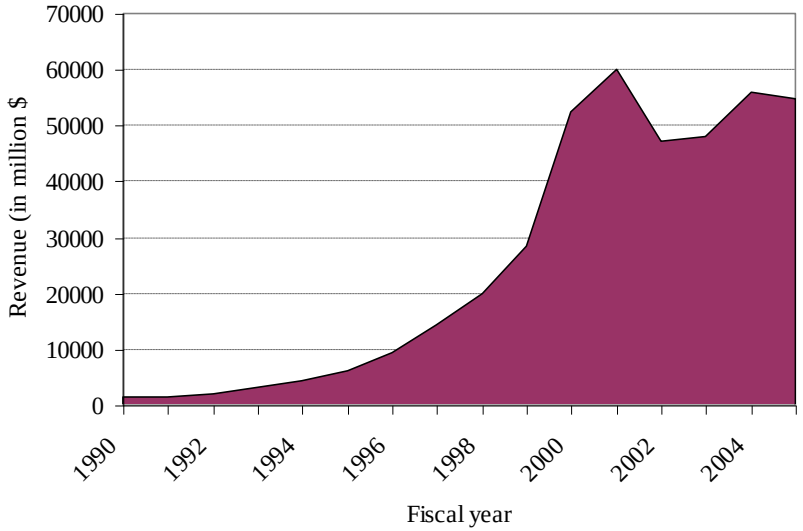
These data are collected via simulation

- Note: 20 links can provide nearly the same performance as total flexibility!

ONE WAY TO MAKE MONEY WITH CAPACITY POOLING: CONTRACT MANUFACTURING

- A fast growing industry:

Total revenue of six leading contract manufacturers by fiscal year: Solectron Corp, Flextronics International Ltd, Sanmina-SCI, Jabil Circuit Inc, Celestica Inc and Plexus Corp. (Note, the fiscal years of these firms vary somewhat, so total revenue in a calendar year will be slightly different.)



- But one with low margins:

Firm (2005 fiscal year)	Revenue*	Cost of goods*	Gross Margin
Flextronics	15288	14090	7.8%
Sanmina-SCI	11735	10924	6.9%
Solectron	10441	9676	7.3%
Celestica	8471	7869	7.1%
Jabil Circuit	7524	6716	10.7%
Plexus	1229	1099	10.5%

* in millions of $s

RISK POOLING SUMMARY

- Risk pooling strategies are most effective when total demand uncertainty is lower than the uncertainty for individual products/locations.
- A little bit of risk pooling goes a long way:
  - With location pooling the biggest bang is from pooling a few locations
  - With capacity pooling a little bit of well designed flexibility is very effective.
- Risk pooling strategies do not help reduce pipeline inventory.
- Risk pooling allows a firm to "have its cake and eat it too"
  - It is possible to lower inventory and increase service simultaneously.

FORECASTING SUMMARY

- E(Profit) = E(Demand) – E(costs) – it is the expectation that creates value in information.
- New information results in revisions to prior probabilities in a decision problem which results in NEW *Expected Values* in a decision problem
- Forecasting helps us avoid bad choices and take advantage of good ones.
- Variability is the norm, not the exception
  - understand where it comes from and eliminate what you can
  - accommodate the rest (Pooling, Excess capacity)

Appendix

How to deal with variability?

Reduce Variability

- Variability is "bad information"
- Reduce variability by improving information

About Input (Demand)
Better Forecasting
Better Scheduling

About Process
Reduce Process Variability
Better Quality

Manage Variability

Choose appropriate "Buffer"

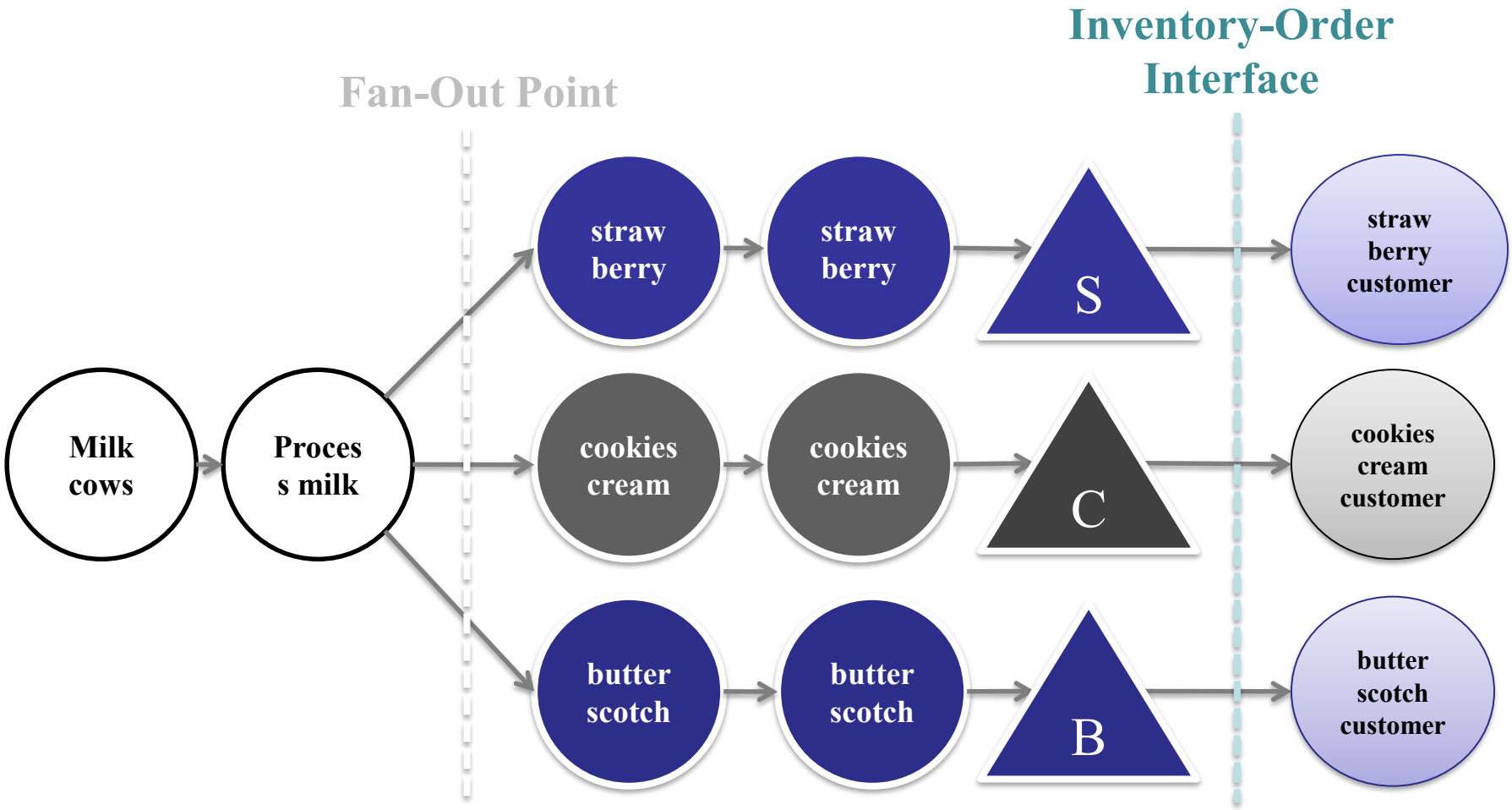
Build adequate *inventory*
and/or
Build adequate *capacity*

Reduce impact of variability by "risk pooling"

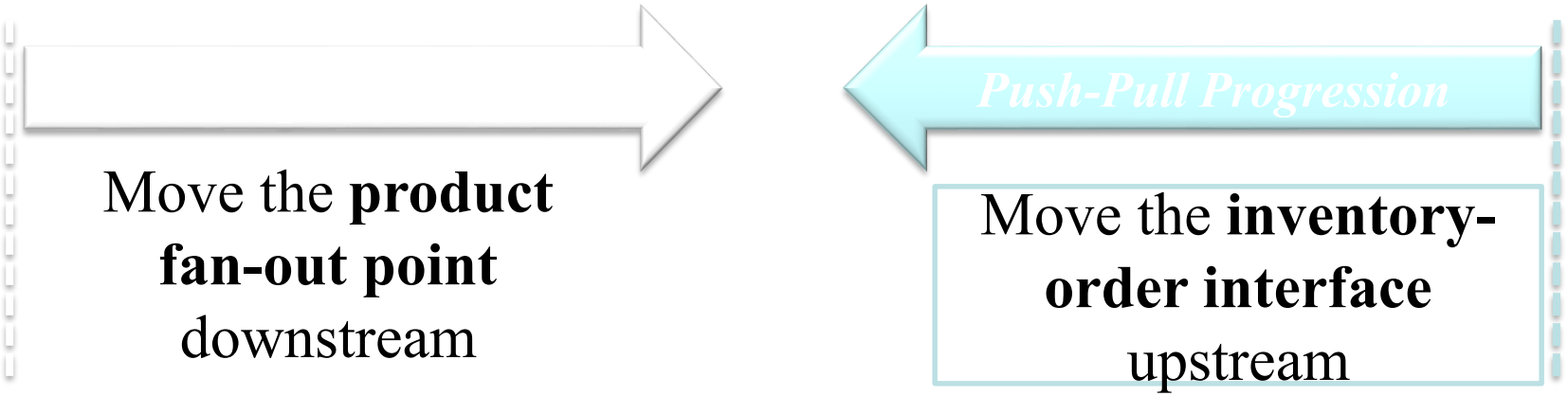
Mass Customization
An Application of Risk Pooling

- What is ***mass customization***?
  - Tries to blend the efficiency of the flow shop (assembly line) with the flexibility of job shop
  - Tries to reduce the impact of demand variability by demand aggregation and risk pooling

PRODUCT FAN-OUT POINT AND THE INVENTORY-ORDER INTERFACE

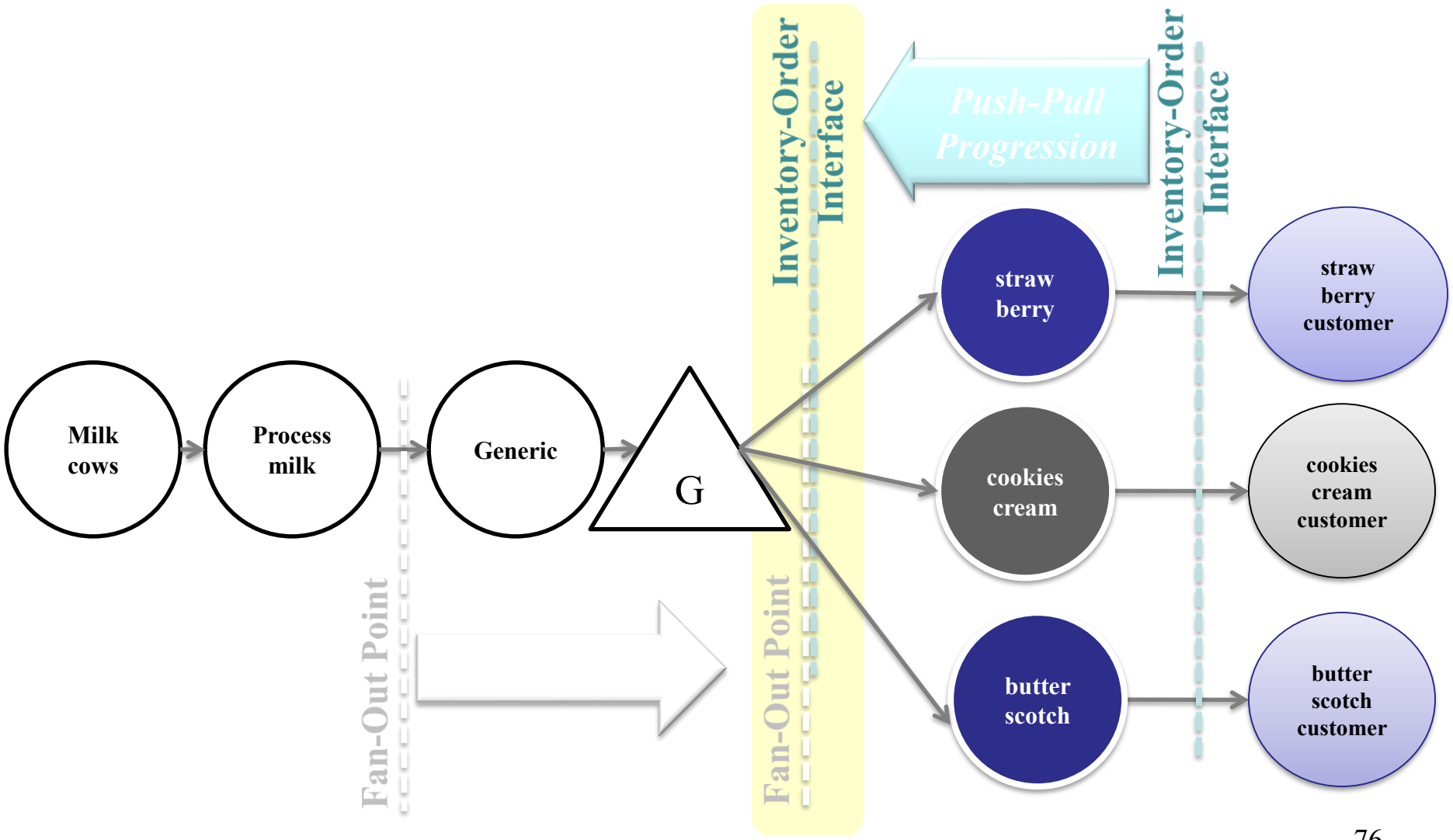


How to achieve mass customization?



Merge the inventory-order interface and the product fan-out point

INVENTORY-ORDER PROGRESSION AND POSTPONEMENT



Mass Customization as Risk Pooling Examples

Benetton makes un-dyed sweaters, and dyes them once "hot" colors are evident

HP Europe makes PCs without power supplies or manuals, make these country-specific additions once country-demand is evident

Warehouses can help achieve geographic delayed differentiation

Selling point at a **home improvement store**

Other examples?


My M&M's® - Personalized Chocolate Candy Messages - Microsoft Internet Explorer
Edit View Favorites Tools Help
Back Search Favorites
http://www.mymms.com/
Go Links
Personalized M&M'S®
with your words, faces and colors!
Place your order today and receive : 10/14/2009
shipping information | price list
MY ACCOUNT
Not a member?
REGISTER HERE
for special offers
SEARCH
GO
There are no items in your cart.
CLICK TO VIEW FULL CART
Enter Promotion Code:
GO
SWEET PROMOTIONS
CLICK TO SEE OFFERS
HOME
HOLIDAYS
CELEBRATIONS
DISNEY NEW
GIFTS
SHOP BY PRODUCT
M&M'S WORLD
PROMOTE your business
CUSTOM PRINTING
SAY IT HERE
FACES ON M&M'S
Celebration Time!
Make it all about them with MY M&M'S®
FREE BONUS BAG
Get This Deal NOW!
Tiff is 16
MY M&M'S For Your Business
A sweet way to grow your bottom line GET STARTED
Build a Future
FJC REALTY
Internet

EXAMPLE: *LEVI STRAUSS*

- *Original Spin*: customizable jeans
  In select Levi's stores or department stores

Create customized jeans

Get measured
Choose from three basic models
Pick from five leg openings
Choose button fly or zipper
Choose fabric and color

Delivery

Measurements emailed to factory
Cloth is laser-cut and then sewn
Delivery within three weeks
Cost to consumer: about $60
fabric and color