REanalyze℠

Supply Chain, Inventory Management and Analytics Consulting

Lessons Learned in Supply Chain, Inventory Management and Analytics

Presentation to APICS Student Chapter Farmingdale State College

Rob Ende MS, MBA, CSCP

November 1, 2011

Objectives for Today's Discussion

- Provide some background on a career spanning:
  - Supply chain, inventory management and analytics
  - Operating roles, internal consulting and outside consulting
  - Analyst level all the way to Corporate VP
- Review some Supply Chain & Inventory Management basics
- Describe a few interesting "real life" projects
- Offer some "lessons learned"
  - Many of them learned the hard way – through failure

Agenda

- Background
- Inventory Management Basics
- Project Examples
  - Arrow Electronics
  - Leviton Manufacturing
  - REanalyze clients
- Lessons Learned
- Q&A

Biography

- B.S. in Aerospace Engineering from Penn State
- M.S. in Aeronautics and Astronautics from Stanford
- Grumman Aerospace Corporation – Aerodynamics Engineer
- MBA (and “Cohort Geek”) from Wharton -- Operations Management & Marketing
- Boston Consulting Group
- Brandwise.com – Director of Strategic Planning
- Arrow Electronics
  - Staff Assistant to the CEO
  - Team Leader – Manugistics Implementation
  - Manager / Director Supply Chain Analysis & Optimization
- Leviton Manufacturing Company - VP Supply Chain
- REanalyze Inc. – Founded March 2011

REanalyze Inc. Mission Statement

Help manufacturing and distribution companies transform their business and realize significant business value by:

- Improving critical supply chain, demand planning and inventory management processes
- Solving challenging supply chain and business strategy problems through the use of advanced analytical methods
- Enhancing and augmenting their analytical and spreadsheet modeling capabilities, from diagnostics and training through custom design & development
- Translating executive-level vision and strategy into critical analysis, problem-solving, communication and implementation

What We Do: Capabilities and Typical Client Benefits

Inventory & Supply Chain Process Improvement	Quantitative Analysis	Analytical & Spreadsheet Modeling Support
• Demand Planning and Forecasting • Inventory Stocking and Replenishment • Item Classification and Segmentation	• Inventory Management • Logistics Network Modeling & Optimization* • Product Strategy and Portfolio Management • Market Analysis and Financial Modeling	• Capabilities audit and spreadsheet diagnostics • Training & staff development • Custom spreadsheet design & development
• Increased inventory turns • Lower excess and obsolete inventory • Improved customer service • Greater staff efficiency	• Lower operating costs • Increased revenue • Reduced complexity • Deeper business insight • Enhanced decision-making	• Better decision-making tools and information • Greater efficiency and effectiveness of analysts • Risk avoidance

* In partnership with Diamond Head Associates, Inc.

Agenda

- Background
- Inventory Management Basics
- Project Examples
  - Arrow Electronics
  - Leviton Manufacturing
  - REanalyze clients
- Lessons Learned
- Q&A

The overall purpose of inventory is to cover imbalances between supply and demand

Key Types of Inventory	Purpose
Pipeline stock	Cover demand over lead time
Cycle stock	Cover demand until next order is placed (“sawtooth”)
Safety stock (aka buffer stock)	Protect against variability in supply and demand

Each type of inventory can take various forms:

- Raw materials
- Work-in-process (WIP)
- Finished goods (FG)

Key Concept: Types of Inventory Systems (Replenishment Policies)

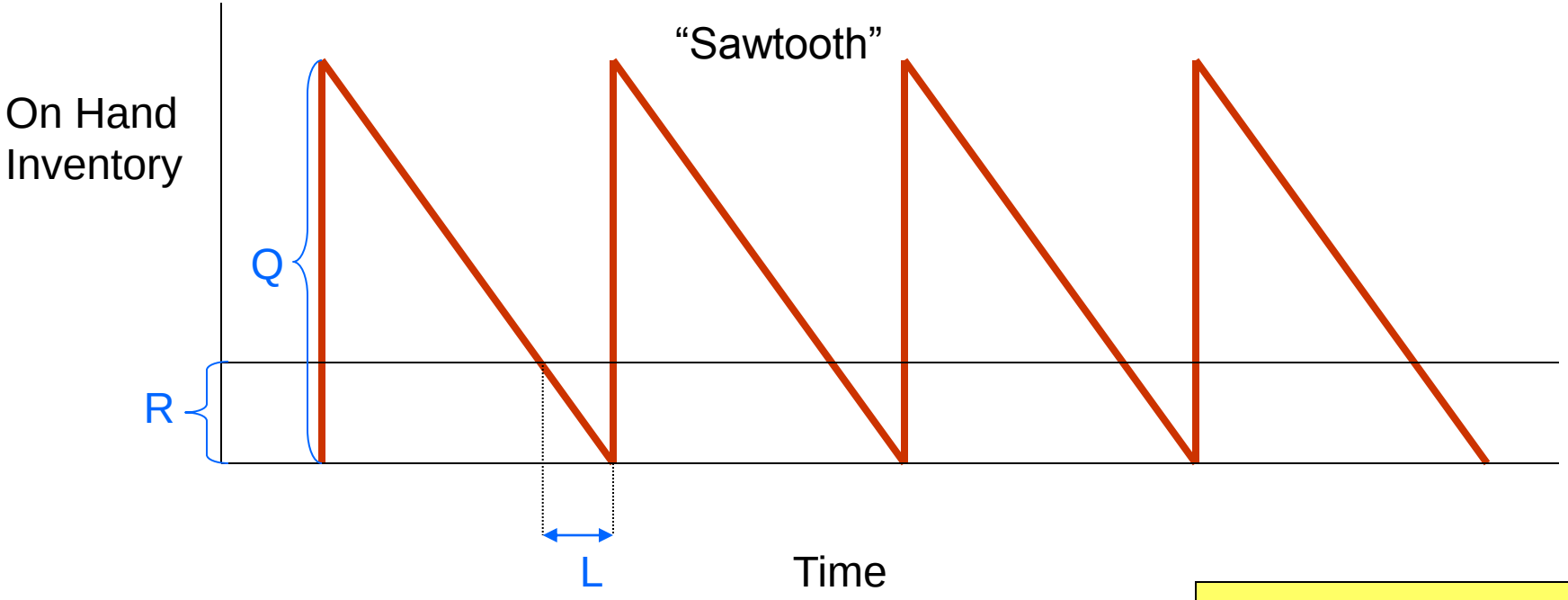
Definition: Inventory position
- Sum of on-hand inventory plus on-order quantity ("due-in")

- Fixed Order Quantity Models (Q models)
  - "Event-triggered"
  - Monitor inventory position continuously
  - Place an order when inventory position falls below the reorder point
  - Typically order the same quantity each time (often the Economic Order Quantity or EOQ)

- Fixed Time Period Models (P models)
  - "Time-triggered"
  - Review inventory position and place orders only at fixed intervals (e.g., weekly, monthly)
  - Order quantity varies each time an order is placed
  - Was more common when computing power was scarce

Illustration: Fixed Order Quantity (Q) Model

When inventory falls below reorder point R, place an order for reorder quantity Q



Note:
Reorder point = expected demand over lead time

L = Lead Time
R = Reorder Point
Q = Reorder Quantity

Fixed Order Quantity (Q) Model (cont.)

- What should the reorder point R be?
  - If demand is consistent, R is just the amount of demand over lead time
  - E.g., If demand is always 1000 per week and lead time is 4 weeks, we need to place an order whenever inventory falls below 4000 units

- What should the reorder quantity Q be?
  - Typically, an Economic Order Quantity (EOQ)

Economic Order Quantity (EOQ)

- The Economic Order Quantity (EOQ) is the order quantity that minimizes the total annual cost

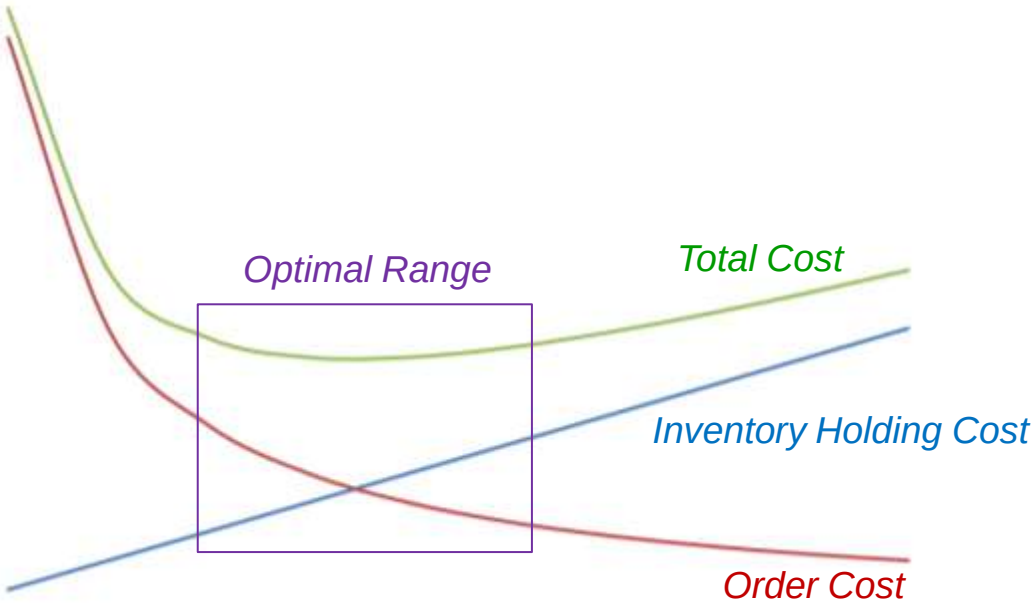
- Total Cost is the sum of:
  - Order or Transactional Cost (# orders x cost per order)
  - Holding Cost (average inventory x annual holding cost per unit)

- EOQ is always a tradeoff between these two costs
  - If Q is small, we place many small orders – transaction costs are high, holding costs are low
  - If Q is large, we place fewer, larger orders – transaction costs are low, holding costs are high
  - What is the “best”?

Economic Order Quantity minimizes total cost

$$EOQ = \sqrt{\frac{2DS}{H}}$$

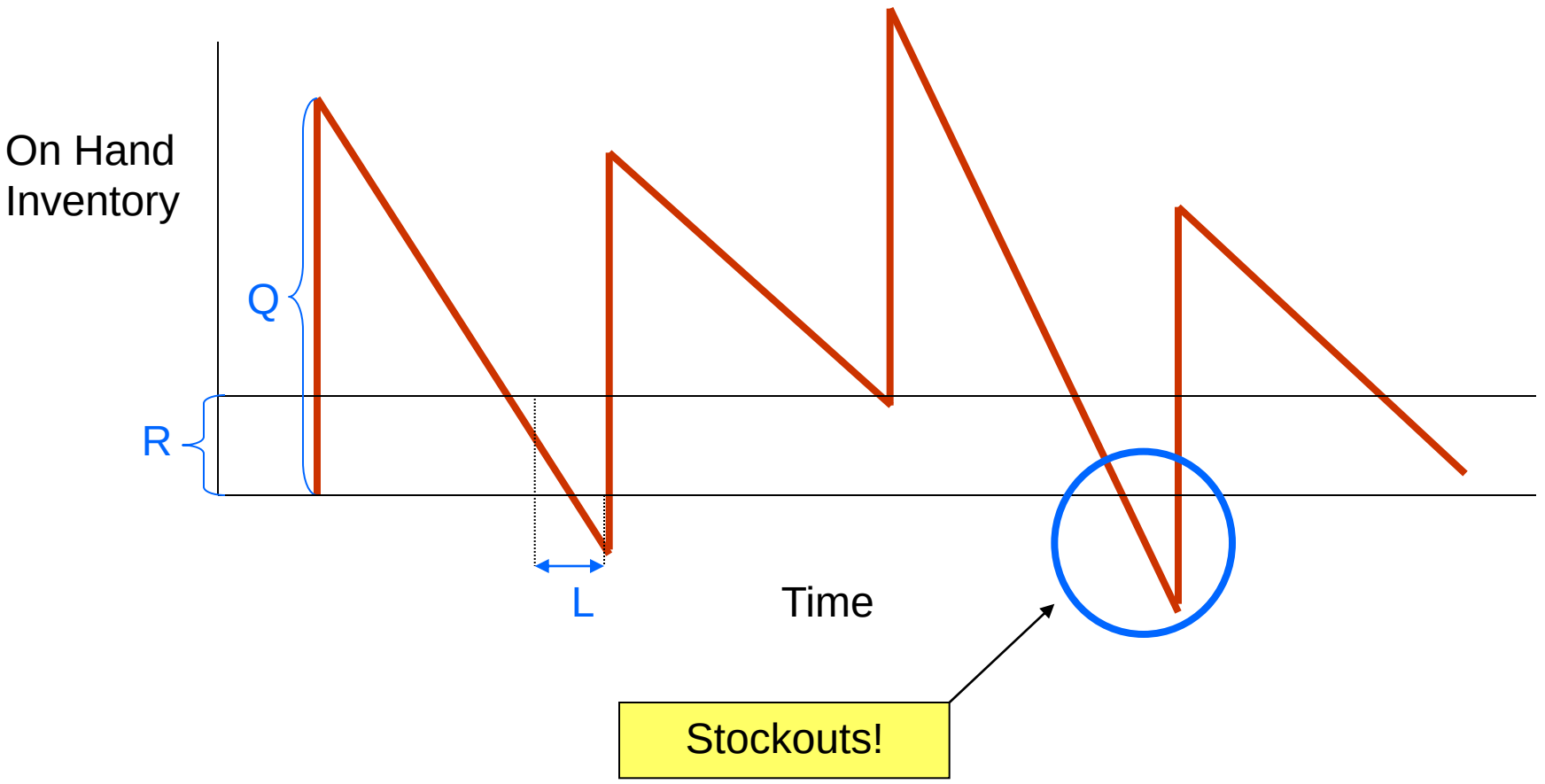
- D = annual demand in units
- S = cost per order (setup, ordering, freight, logistics, etc.)
- H = annual holding cost per unit = iC
  - i = carrying cost % (typically 10-40% per year)
  - C = cost per unit



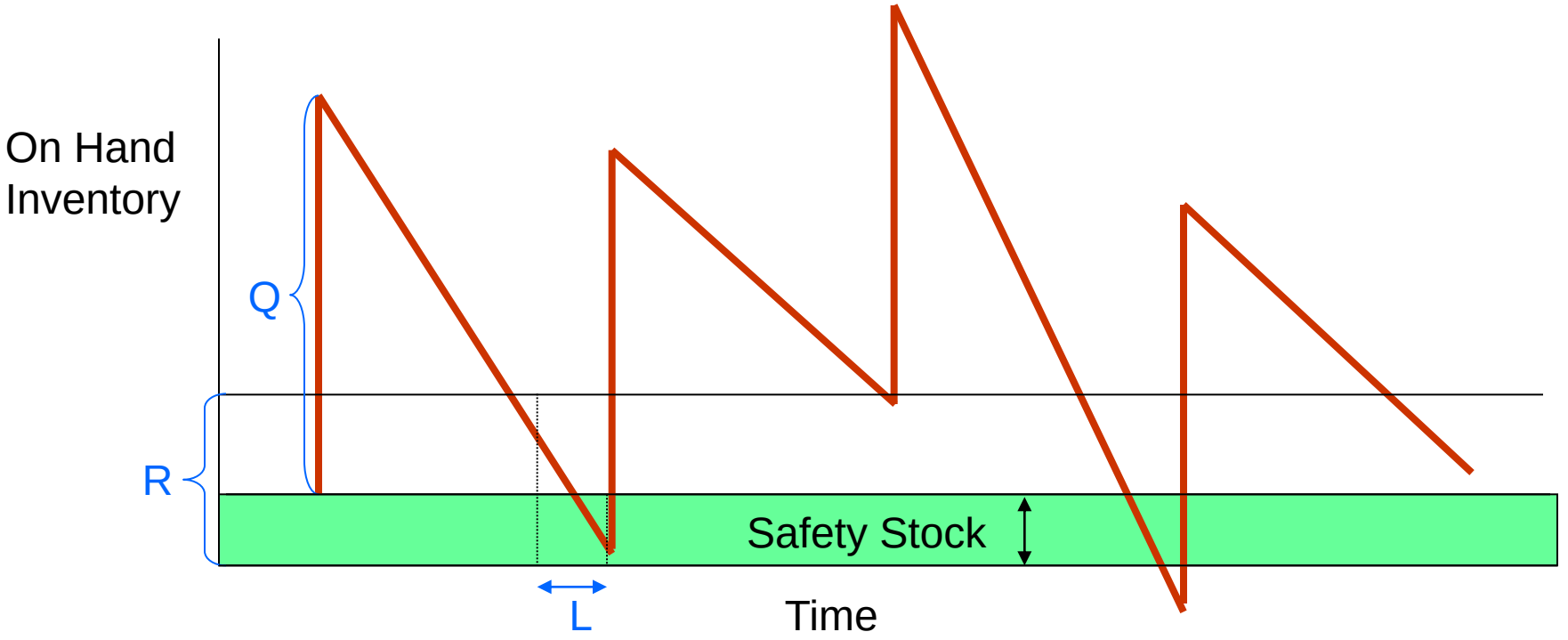
Safety Stock

- In reality, demand and supply are usually not known and consistent
  - Demand varies in each time period, and may increase or decrease over time
  - Lead times are inconsistent and may vary over time
- Safety stock (or buffer stock) is designed to protect against stockouts due to variability in demand and supply
- Example
  - Average demand is 100 units per week
  - We place orders every 2 weeks for 200 units
  - What happens if demand is 150 units one week?

What happens when demand is unpredictable?



Safety Stock protects against stockouts due to variability in demand (and supply)



The higher the percentage of demand we want to be able to meet (service level or fill rate) the more safety stock we need

- Note: Reorder point = expected demand over lead time plus safety stock

Safety Stock (cont'd)

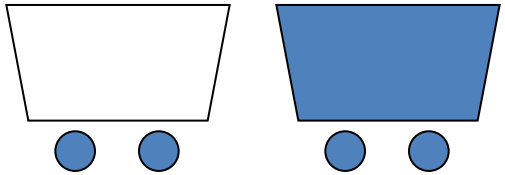
- Based on:
  - Variability of demand (or forecast error)
  - Lead time (and variability of lead time)
  - Desired service level or "fill rate"

- Service Level or Fill Rate
  - What % of demand can I satisfy from on-hand inventory?

- Let's not do the math here…

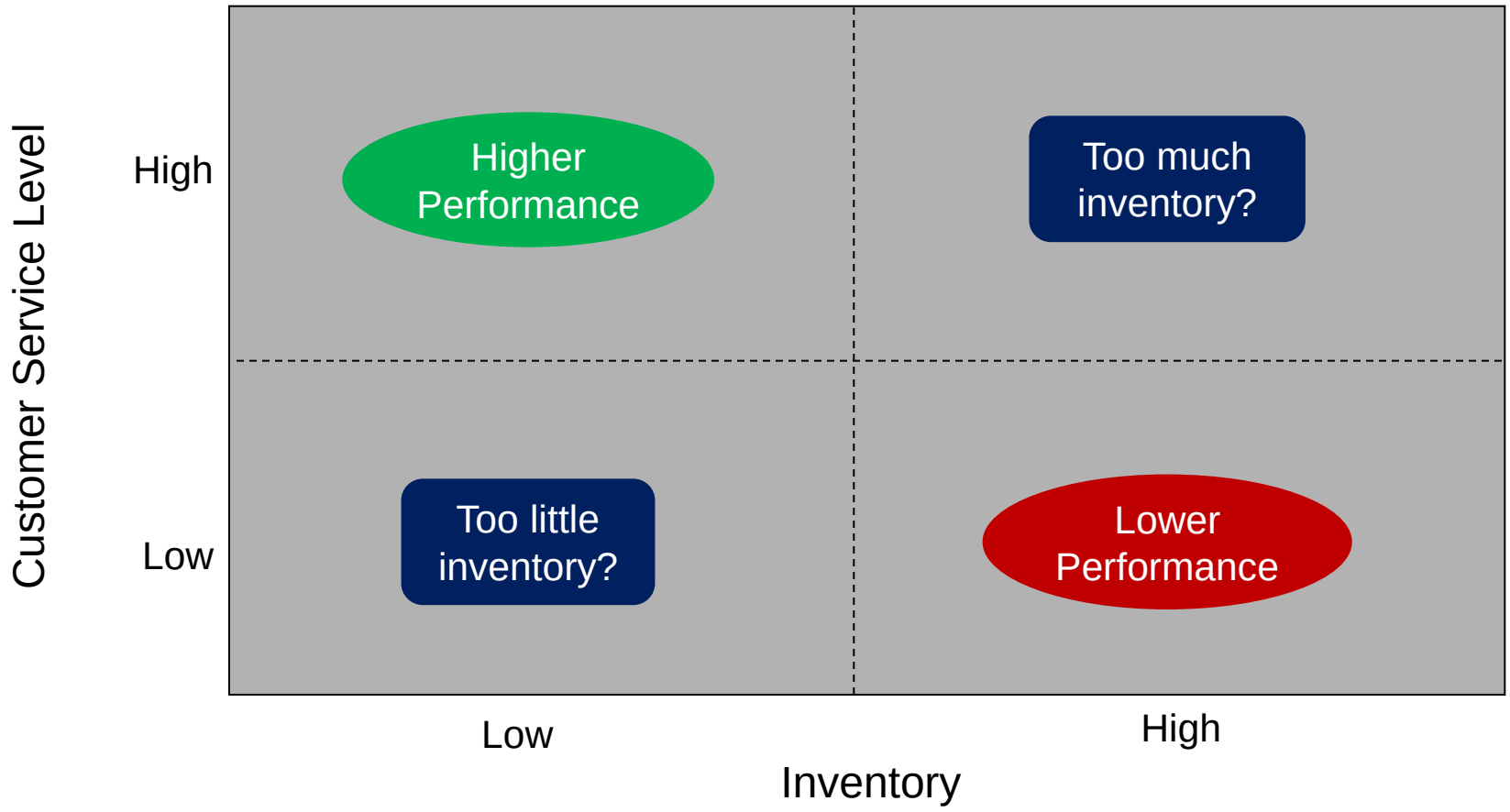
Some Other Types of Inventory Systems

- Kanban (Two-Bin System)
  - When one “bin” is empty, order another full bin
  - Equivalent to a fixed order quantity model where the reorder point equals the order quantity (R = Q)

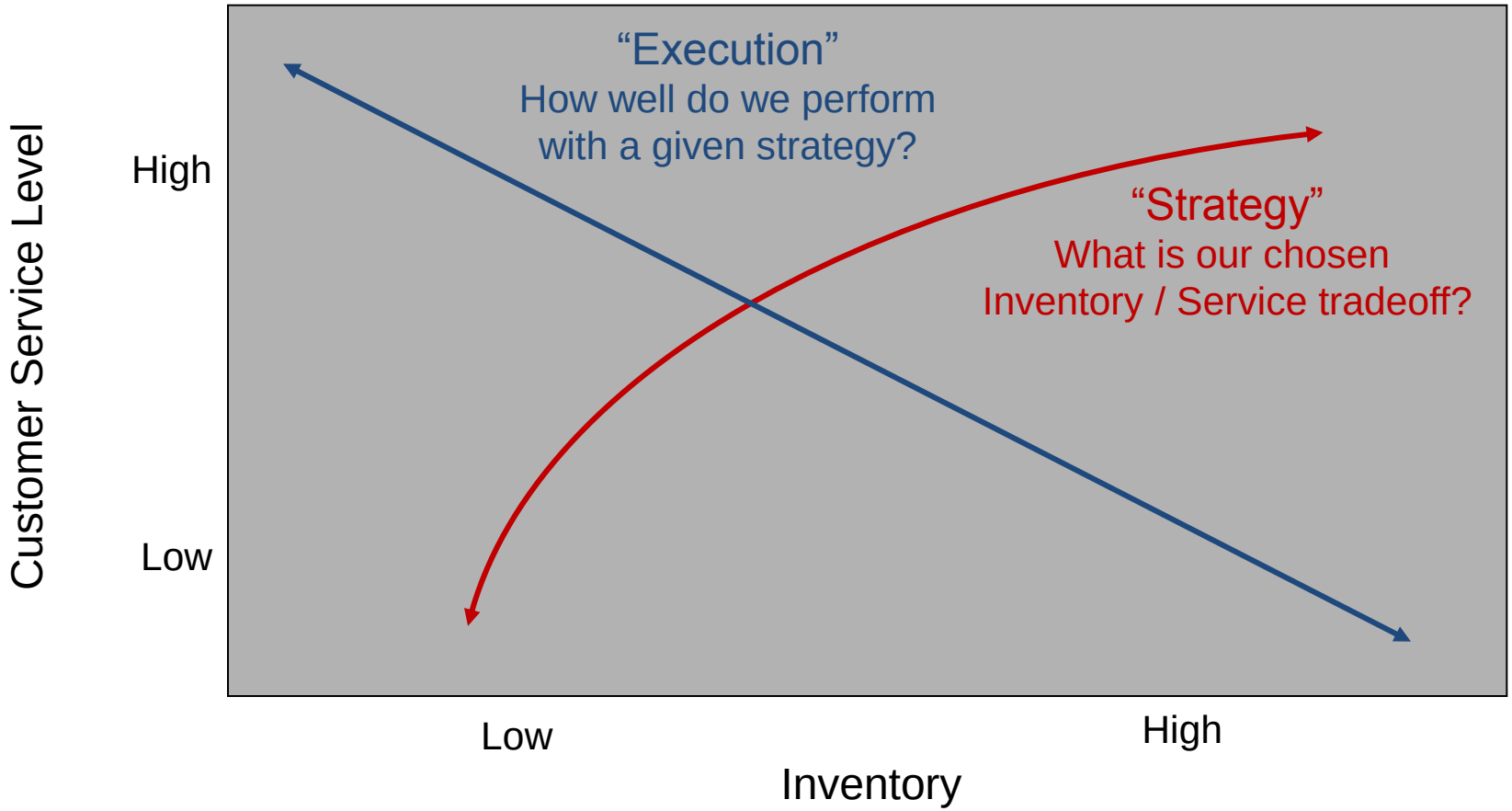


- Just-In-Time (JIT)
  - Minimize required inventory by shortening lead time as close to 0 as possible
  - Replenish “just-in-time” based on actual customer demand
  - Works best for items with very smooth demand

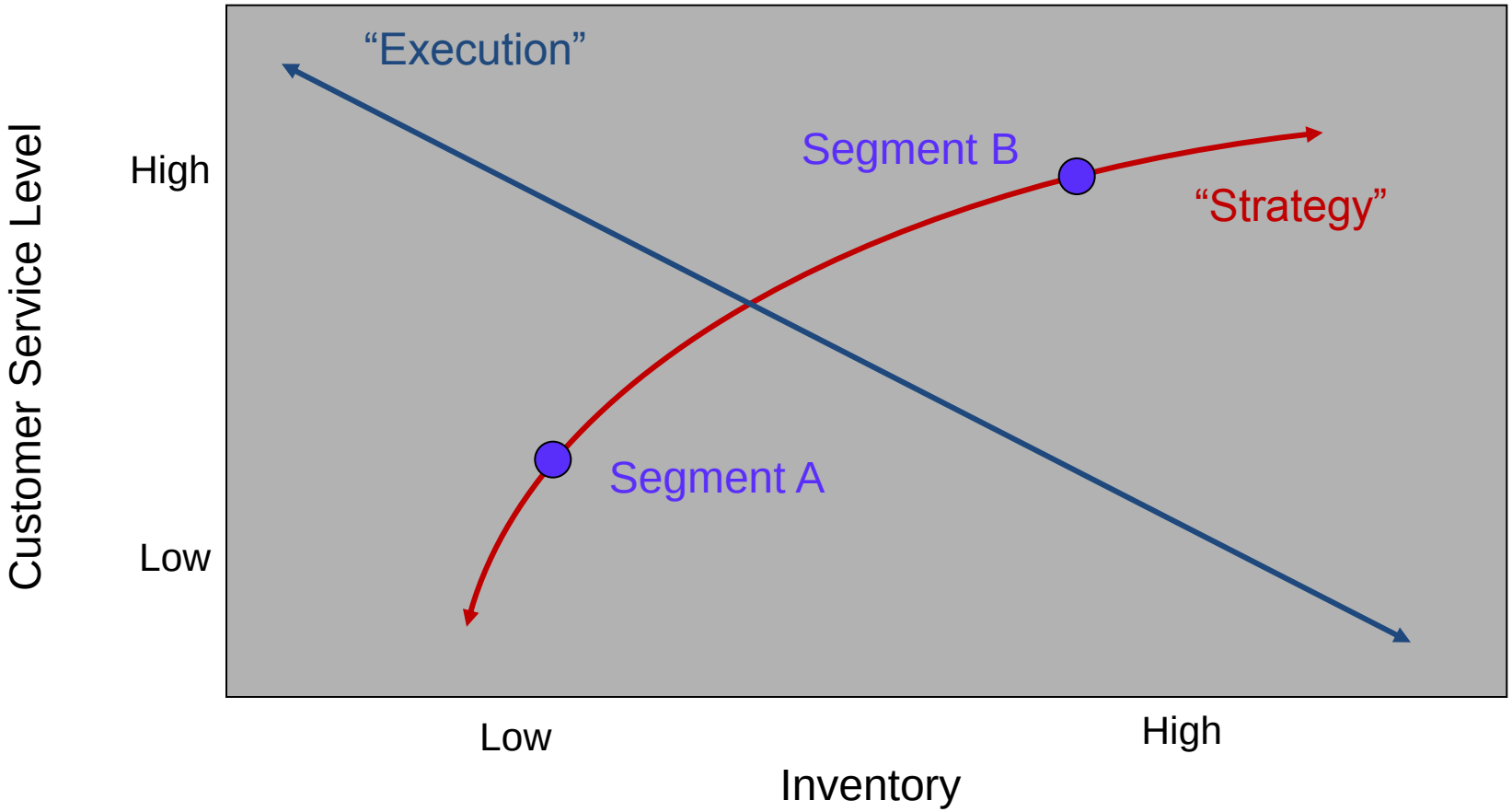
Tradeoff between Inventory and Customer Service



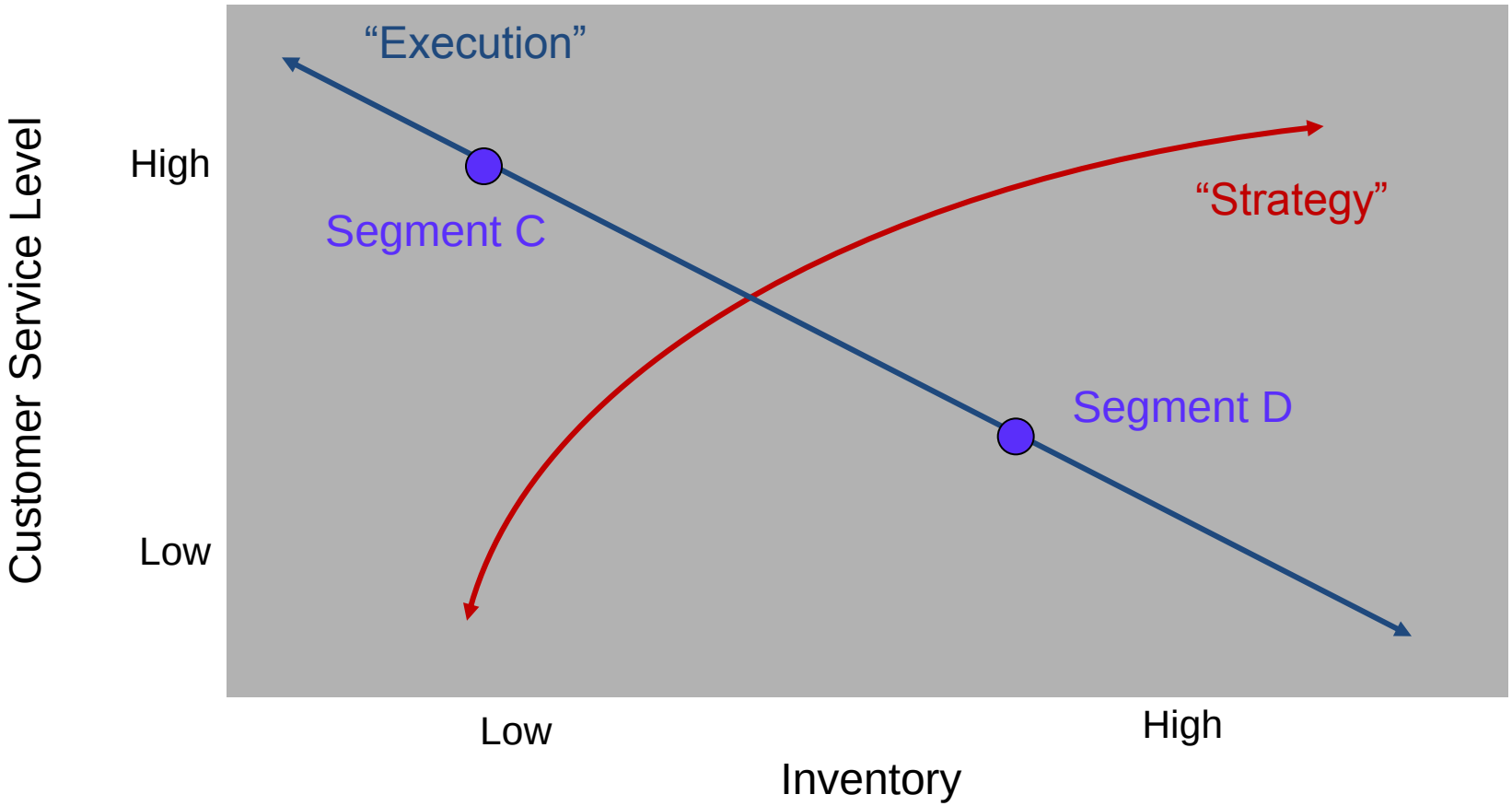
Results can be explained on two dimensions: Strategy and Execution



Which is better, “A” or “B”?

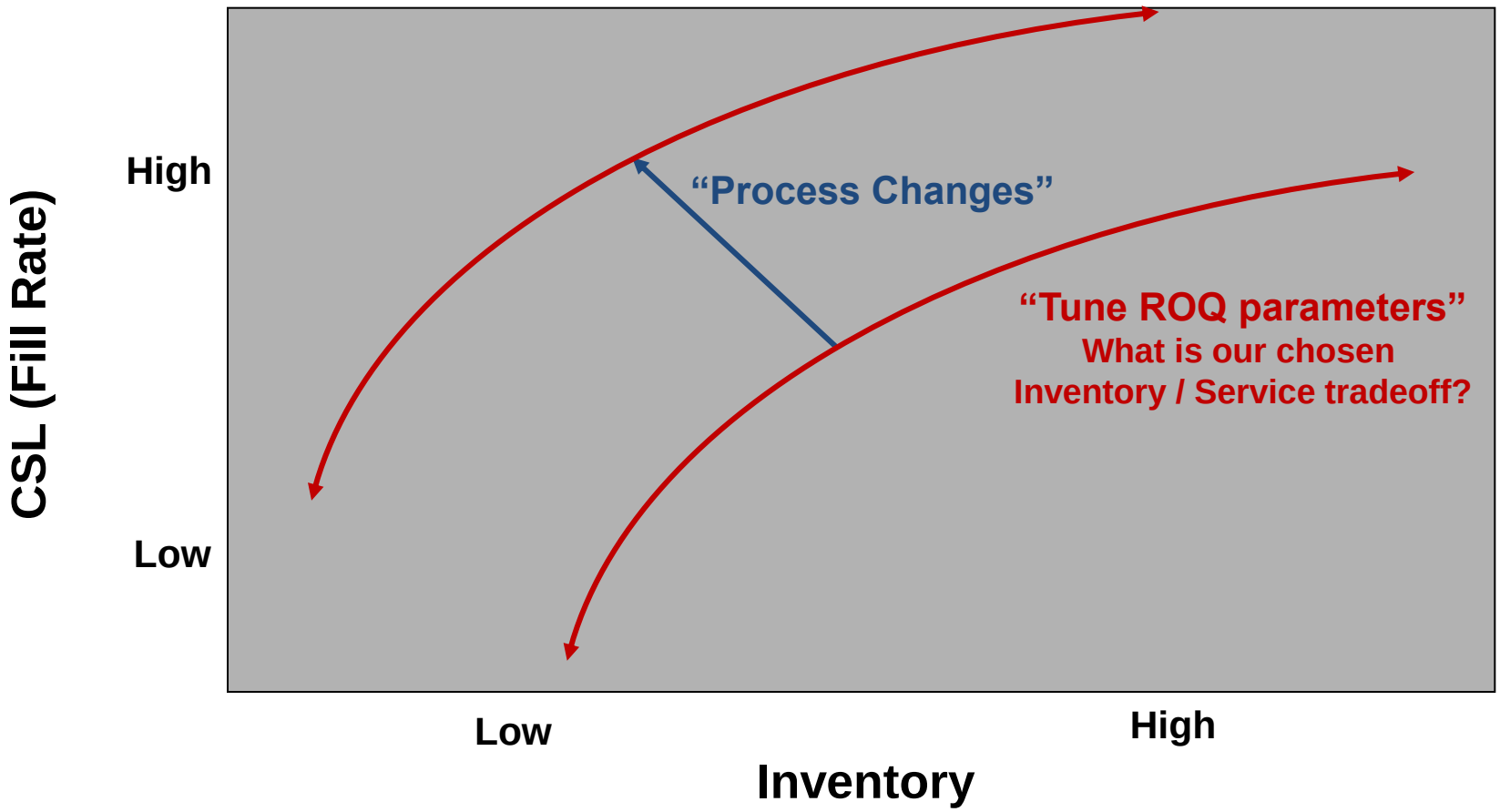


Which is better, “C” or “D”?



The key is process improvement…

Process improvements can “break” the tradeoff between Customer Service and Inventory



Agenda

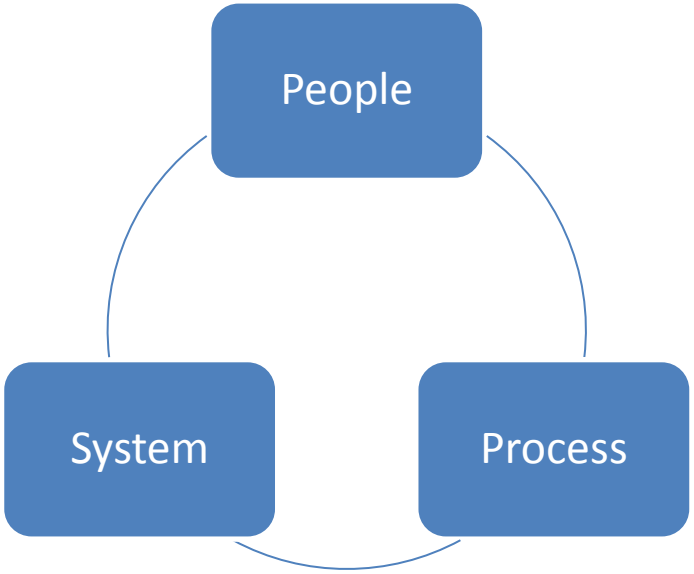
- Background
- Inventory Management Basics
- Project Examples
  - Arrow Electronics
  - Leviton Manufacturing
  - REanalyze clients
- Lessons Learned
- Q&A

Denominator / Manugistics Project Charter (2001-2002)

- Design and implement the industry leading process model for forecast management, inventory optimization, and purchasing decision support

- Fulfill three major objectives:
  - Quantity of Inventory:
    Sustain 5 turns through the cycles
    - Baseline: 4 turns through the cycles with significant fluctuations
  - Quality of Inventory:
    Reduce write-offs by 0.1% of sales
  - Service Level:
    Measure and manage fill rates and other service metrics

Holistic approach:
Not a Systems project



Denominator Project Scope: End-to-end inventory management process

"What will we sell?"

"How much should we hold and where?"

"What should we buy and when?"

Key Design Elements Addressed Each Step of the Process

Categorization & Classification

Aggregation

Statistical Methods

Market Intelligence

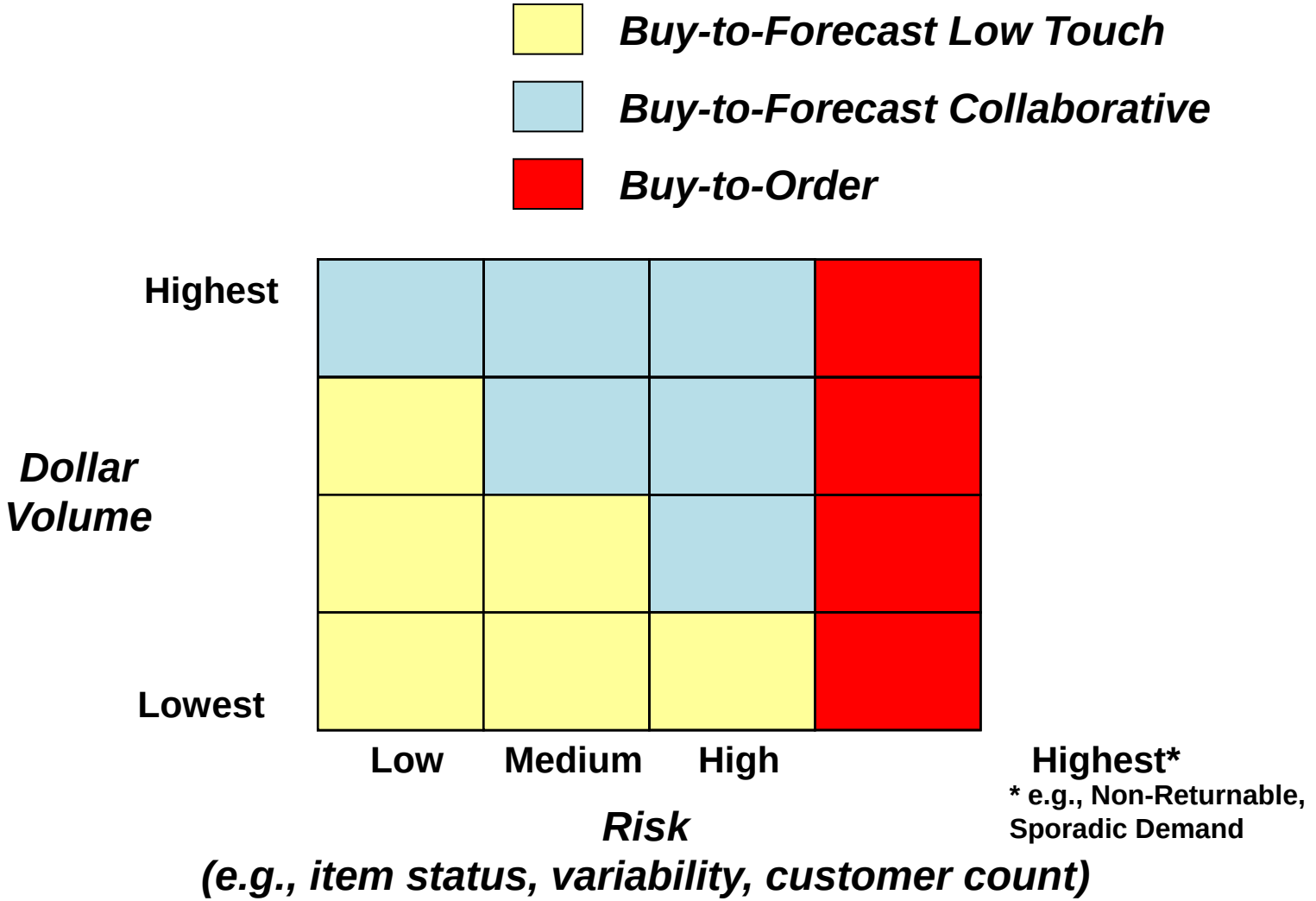
Safety Stock

Order Policies

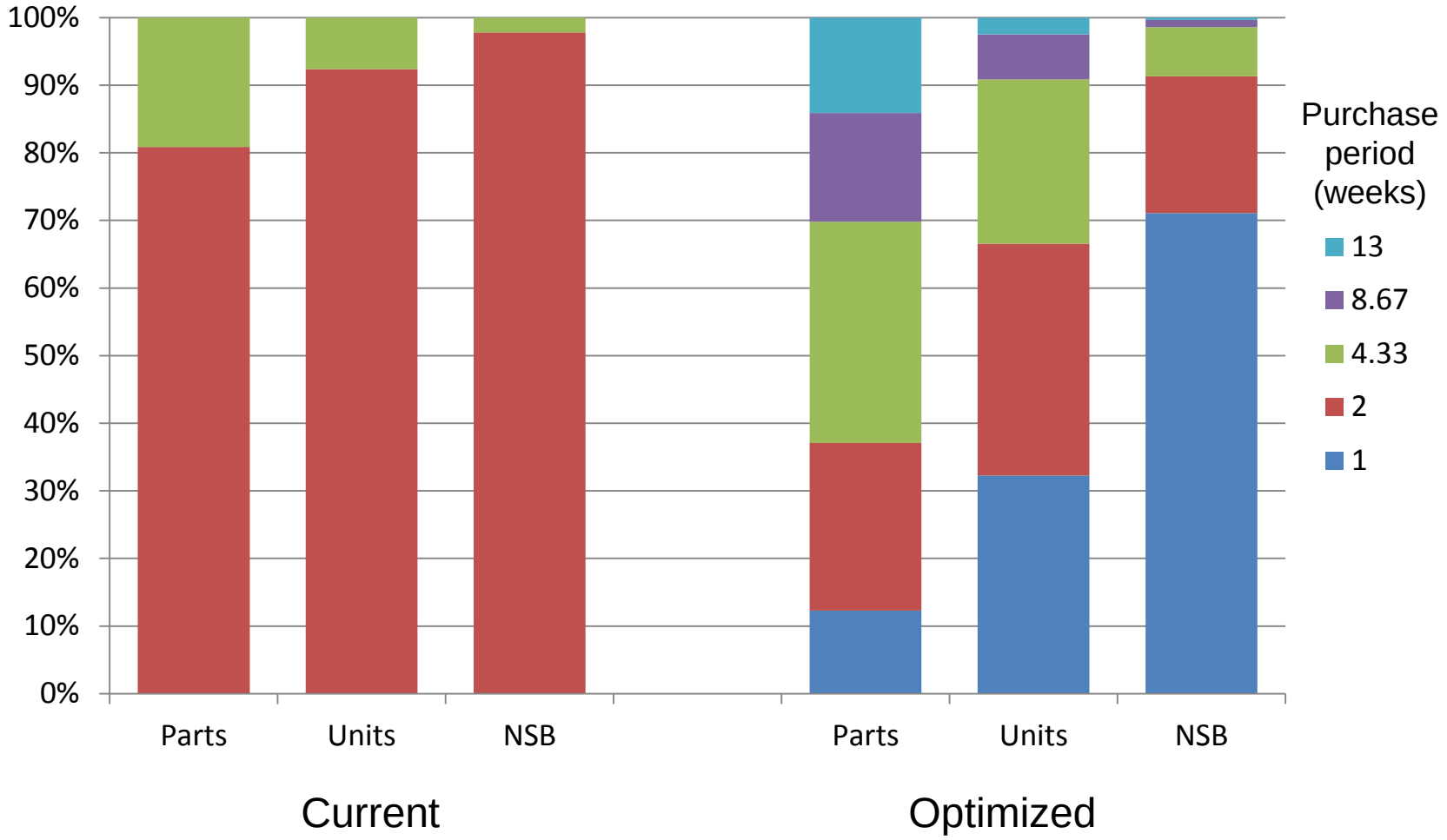
Exceptions & Alerts

Performance Metrics

Item Category calculation drives inventory policies, based on item risk and volume



EOQ Results - Semiconductors



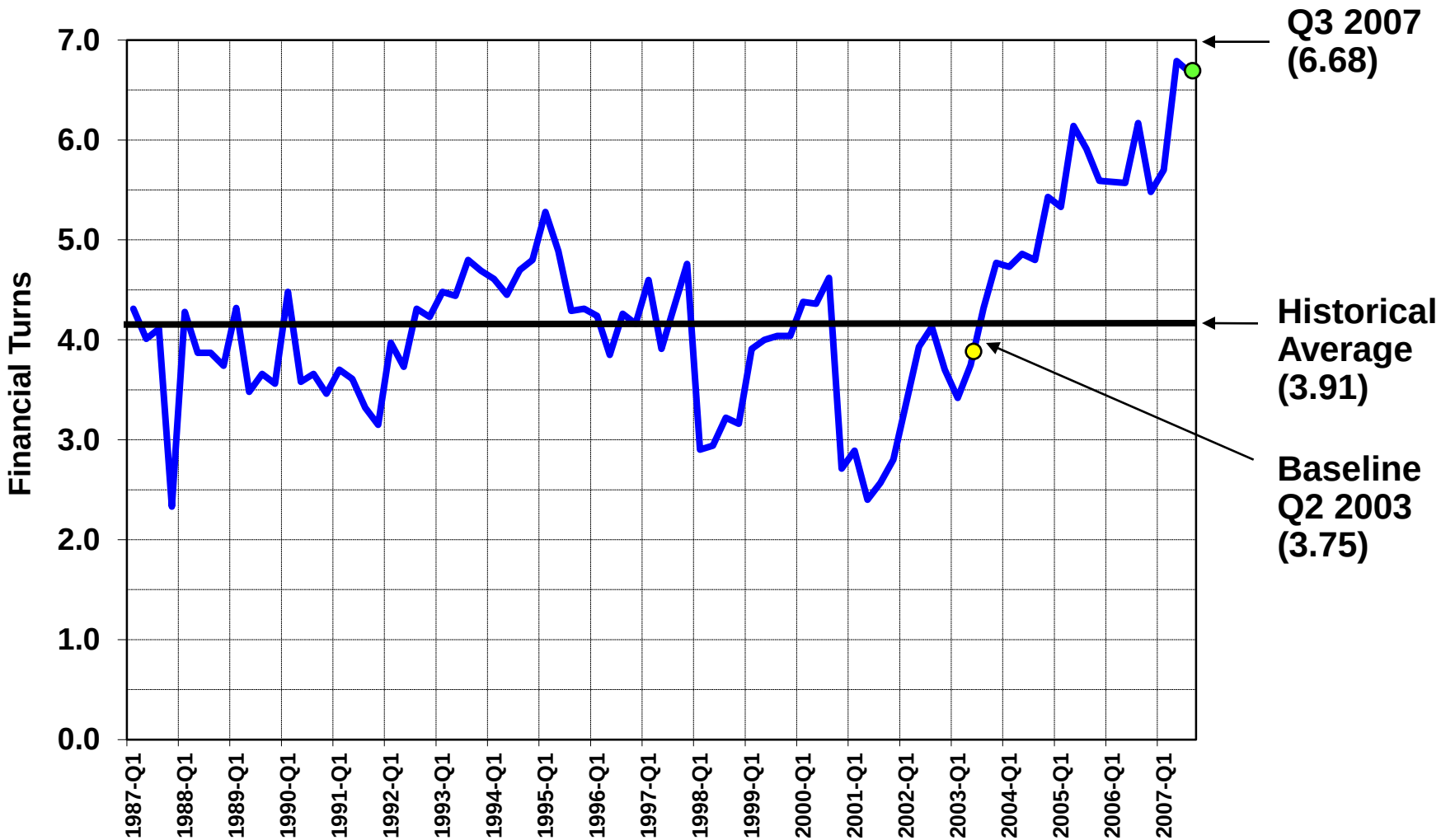
Implementation Lessons Learned

- Those who execute a process should design the process and train others
  - Subject-matter experts & Super Users
- The supply chain is one part of a complex system; consider impact on others
  - Simulate it?
- Up-front training is important; follow-through is crucial
  - Documentation, ongoing support, centers of excellence
- Accountability: What gets measured gets done
  - Metrics, process ownership

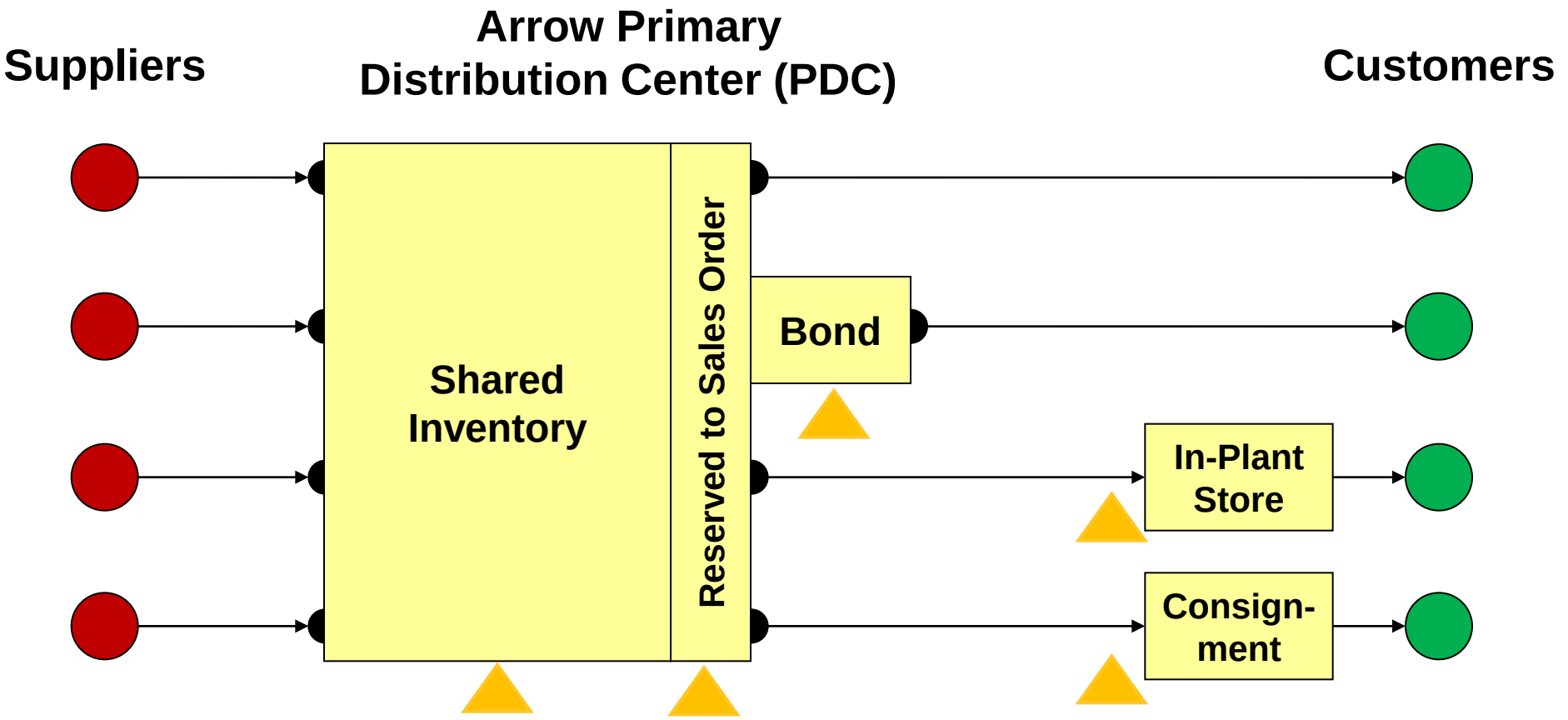
Project Denominator: Results after 2 years

Measure	Planned Results	Actual Results
Investment	N/A	132% of plan (approved increase in scope)
Project duration	13 months	16 months (extended pilot phases)
Inventory quantity	1 turn improvement	Sustained 1.8+ turns increase and still improving
Inventory quality	0.1% reduction in write-offs as % of sales	0.1% reduction in write-offs as % of sales
Service Levels	Measure & monitor (not done previously)	Fill Rate up 2-3%

Long-Term Turns Trend (Semiconductors)



Basic Supply Chain Structure: Multiple Inventory Buffers



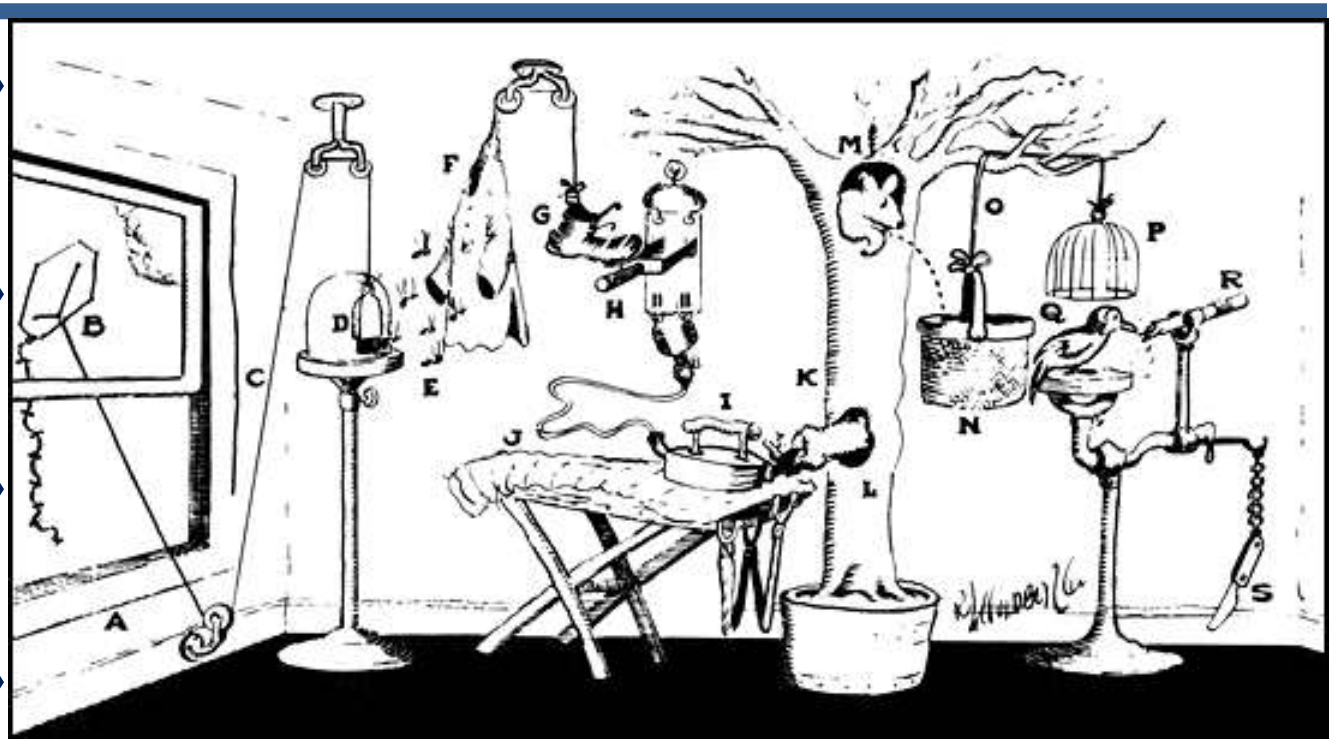
Inventory Simulation Model: The Problem…

Forecast Algorithms

Safety Stock Settings

Purchasing Rules

Forecast Accuracy



Inventory Turns ?

Service Level ?

Transaction Volumes ?

Inventory Simulation Model: The Problem…

Forecast Algorithms

Safety Stock Settings

Purchasing Rules

Forecast Accuracy

JDA / Manugistics
Supply Chain Planning

- **Demand (forecasting)**
- **Fulfillment (safety stock, warehouse balancing)**
- **Supply (purchasing)**

eCOMPASS -- homegrown

- **Customer forecast management**
- **"Restricted" inventory management**

Inventory Turns ?

Service Level ?

Transaction Volumes ?

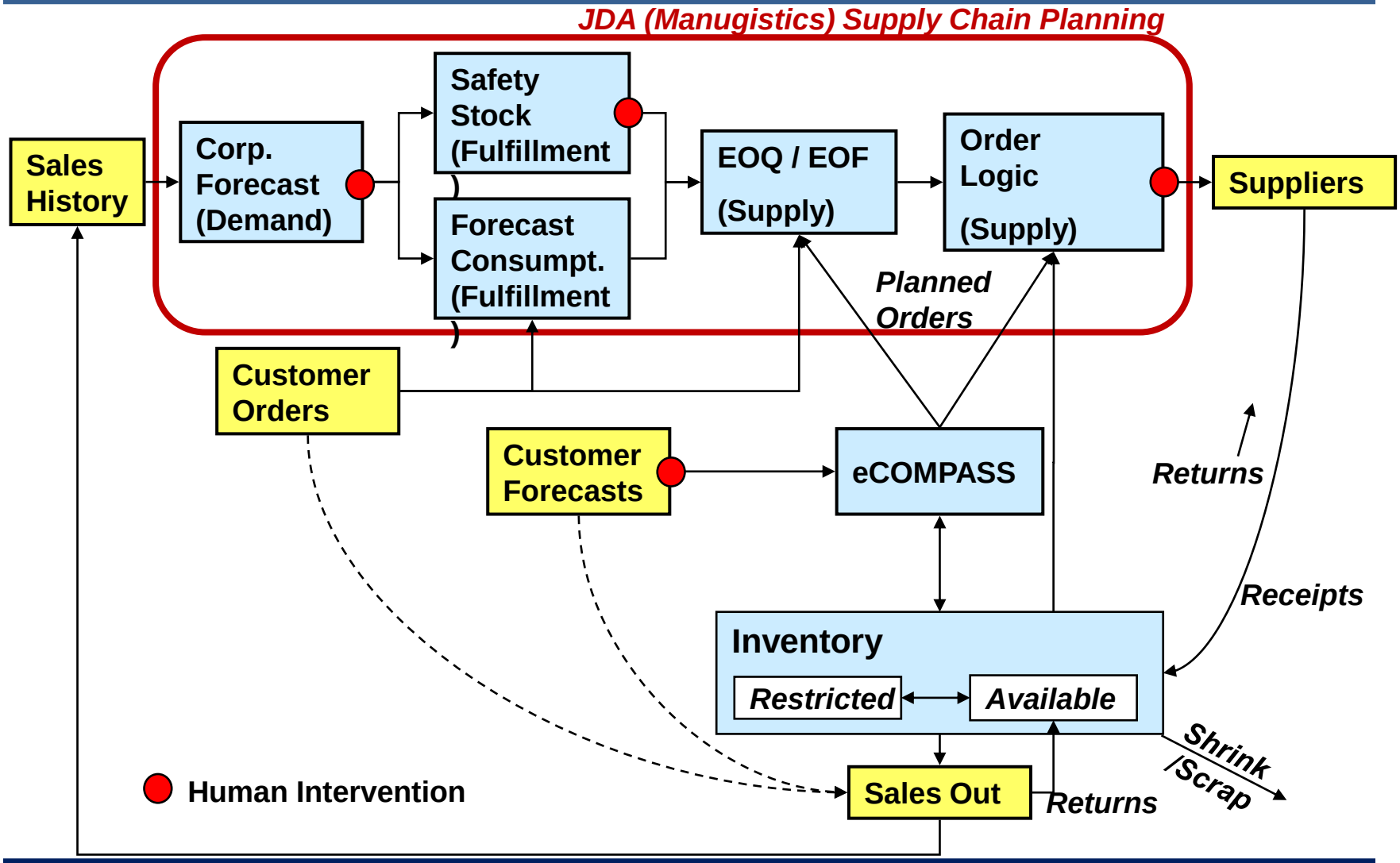
Inventory Simulation Model: Project Objectives

- Build a simulation model to perform “what-if” analysis to estimate impact of:
  - Changes to Manugistics parameters and system logic
  - “Environmental” factors, e.g., market cycles

- Measure impact in terms of:
  - Inventory $ and turns
  - Customer service levels (Fill Rates)
  - Transaction volumes (internal & external)
  - Available to Sell inventory %

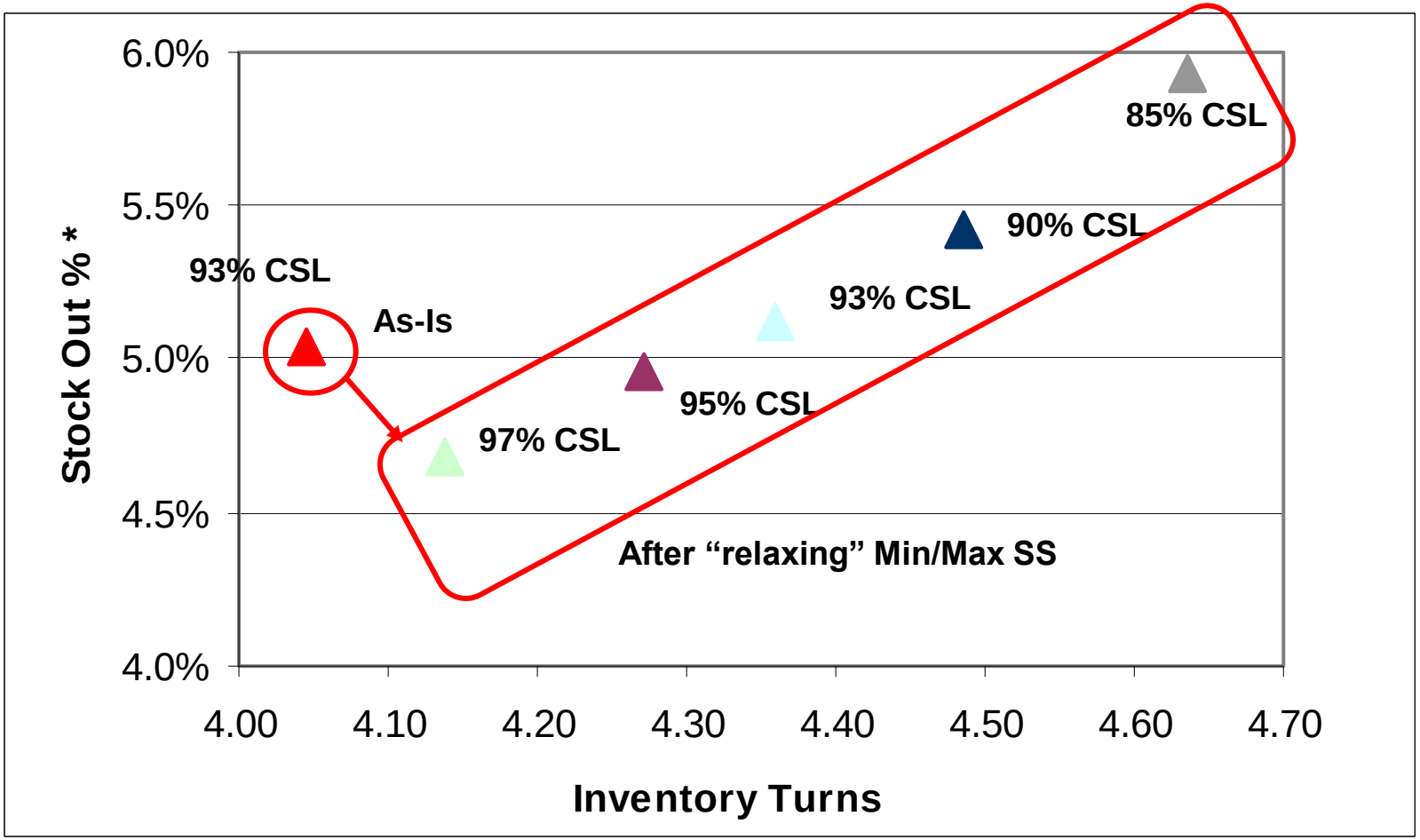
- Provide decision-support to Product Management teams
  - How best to achieve objectives, e.g., specific level of inventory reduction at lowest risk

Conceptual Model

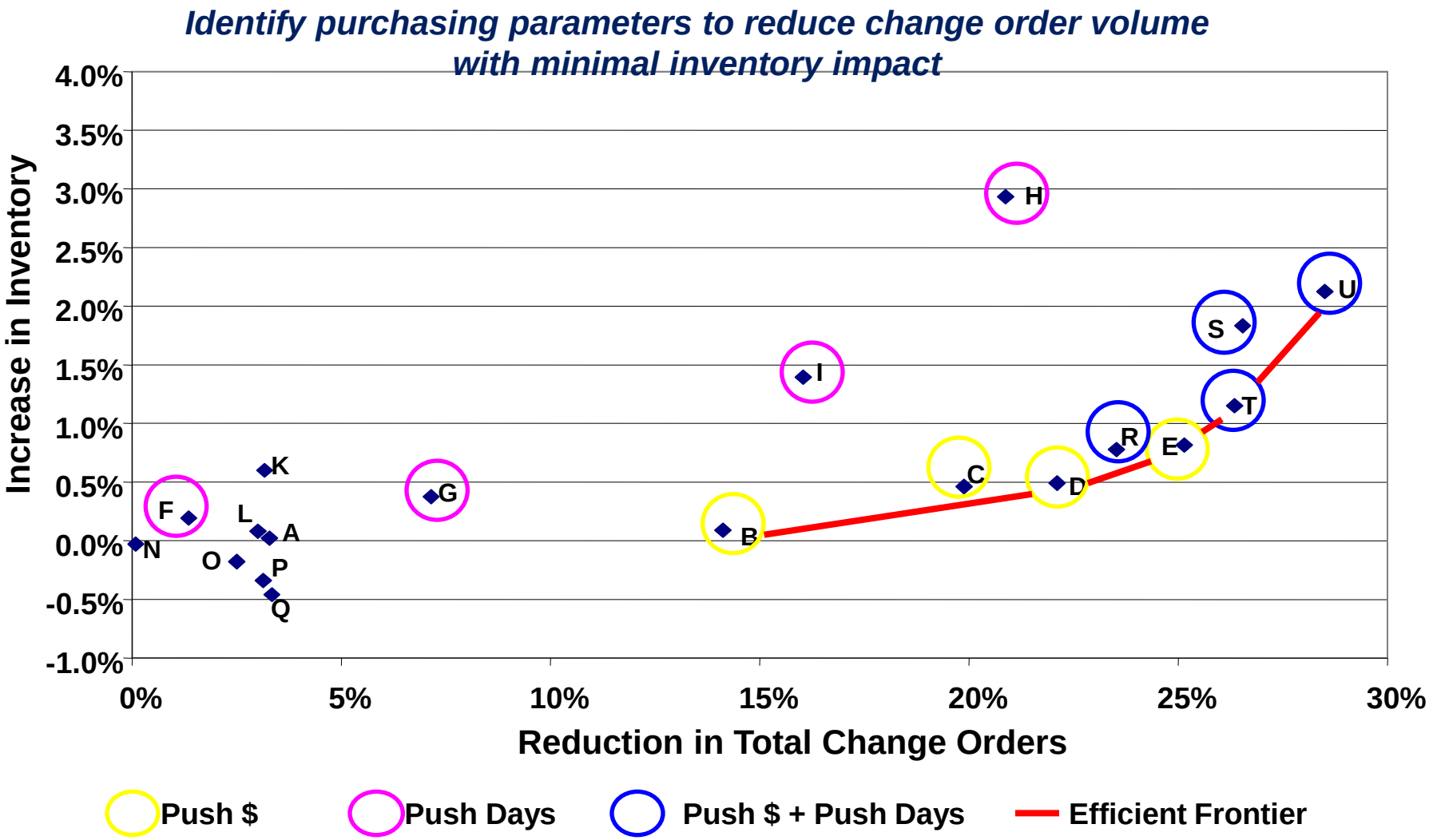


Example: Safety Stock Parameters

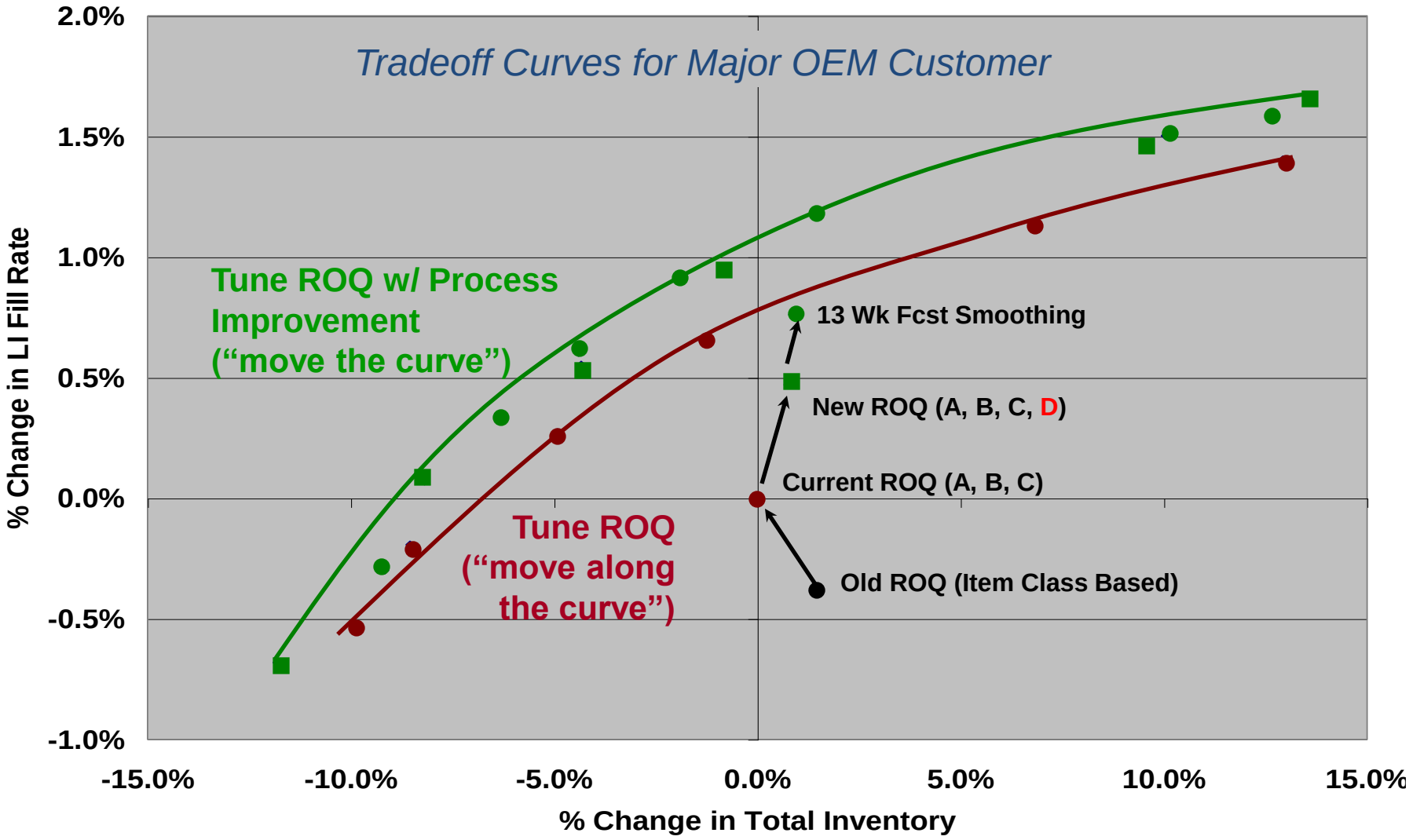
Improved inventory turns and service levels by relaxing min/max safety stock settings



Example: Change Order Reduction



Example: Restricted Inventory Management:



Agenda

- Background
- Inventory Management Basics
- Project Examples
  - Arrow Electronics
  - Leviton Manufacturing
  - REanalyze clients
- Lessons Learned
- Q&A

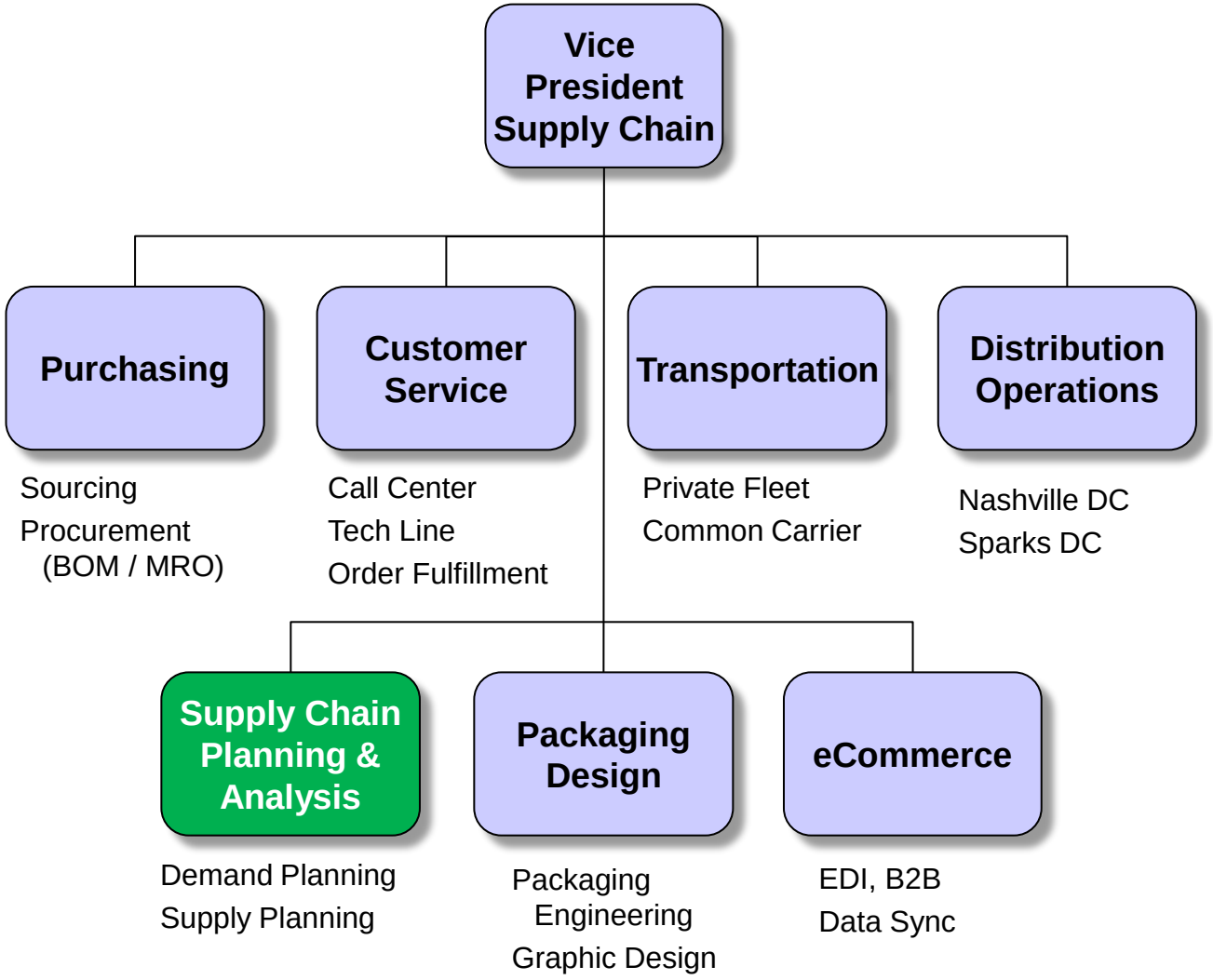
Supply Chain Mission Statement

The Leviton Supply Chain organization will continuously improve the informational, physical, and financial flows within and between Leviton, our Customers and our Suppliers…

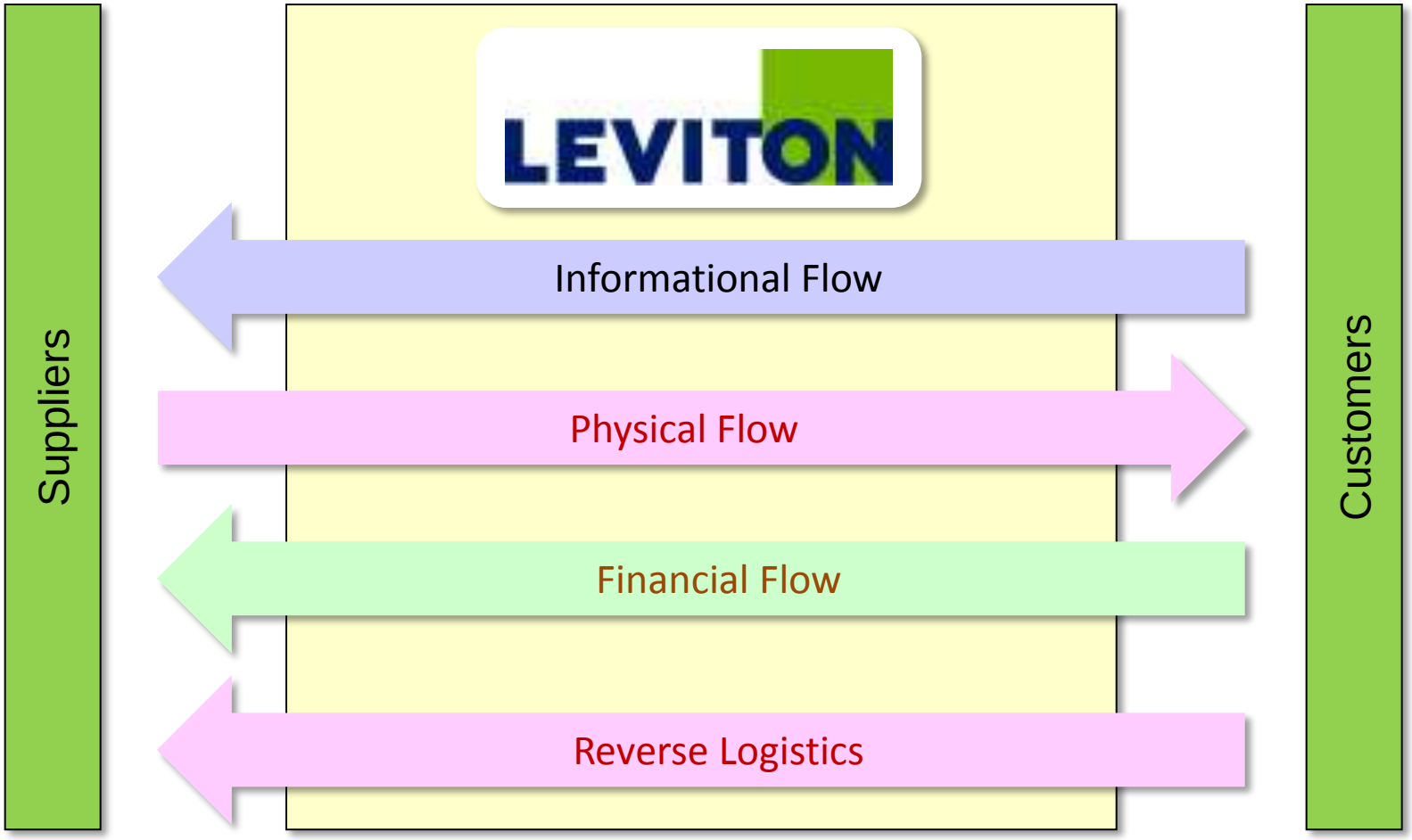
to achieve superior customer service, responsiveness, revenue growth and profitability…

while minimizing operating costs, working capital investment, business risks and adverse impacts to the environment

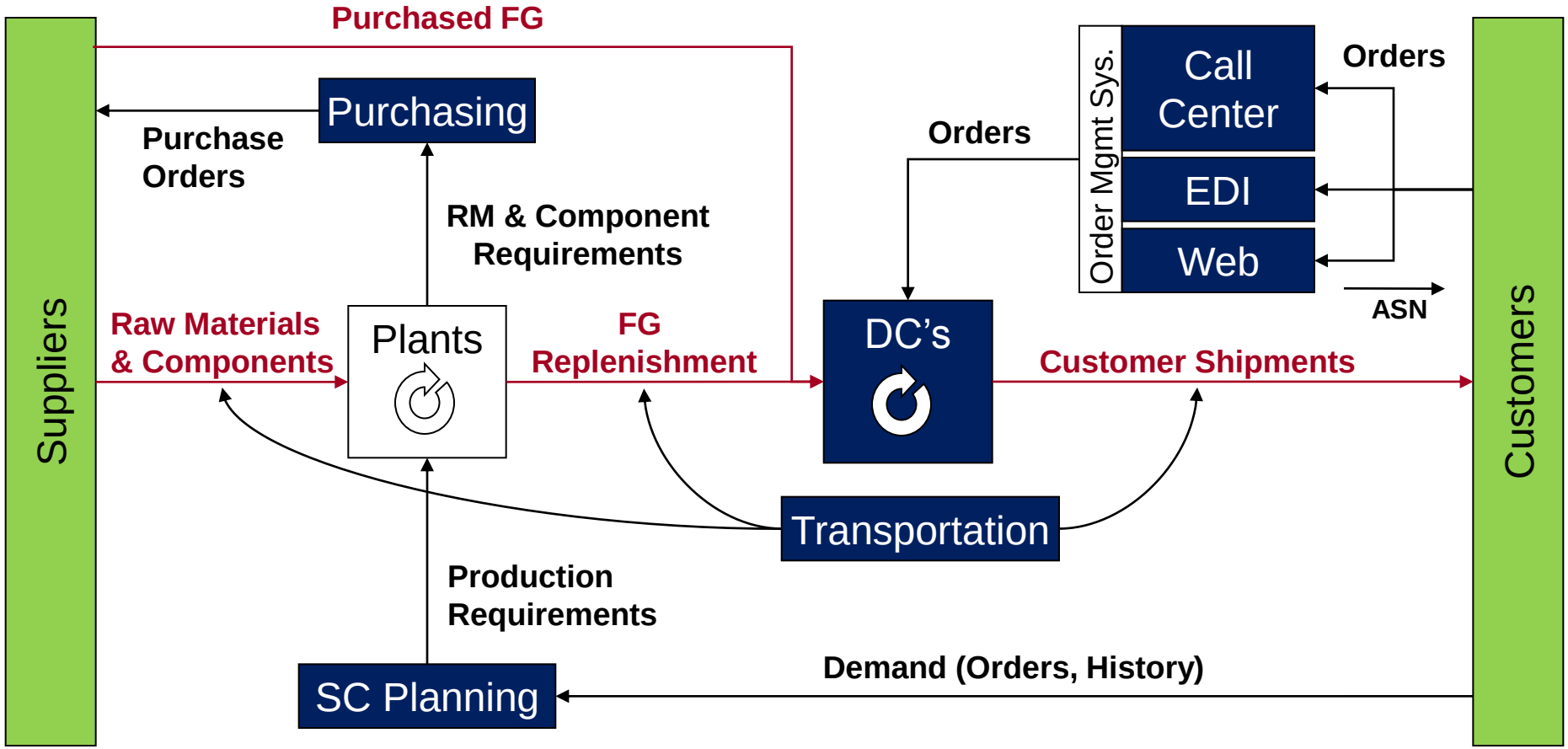
Supply Chain Organization



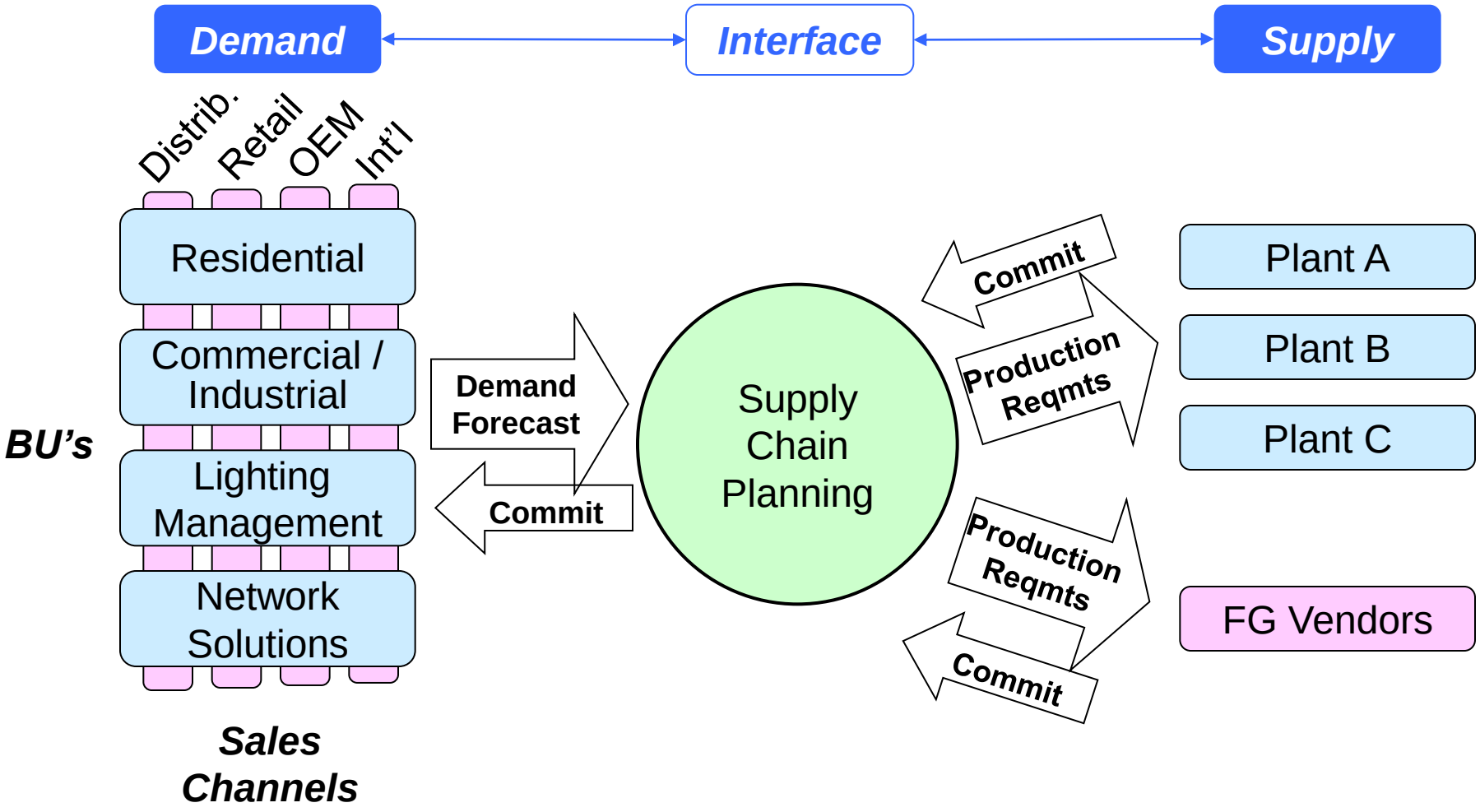
Supply Chain as a Series of “Flows”



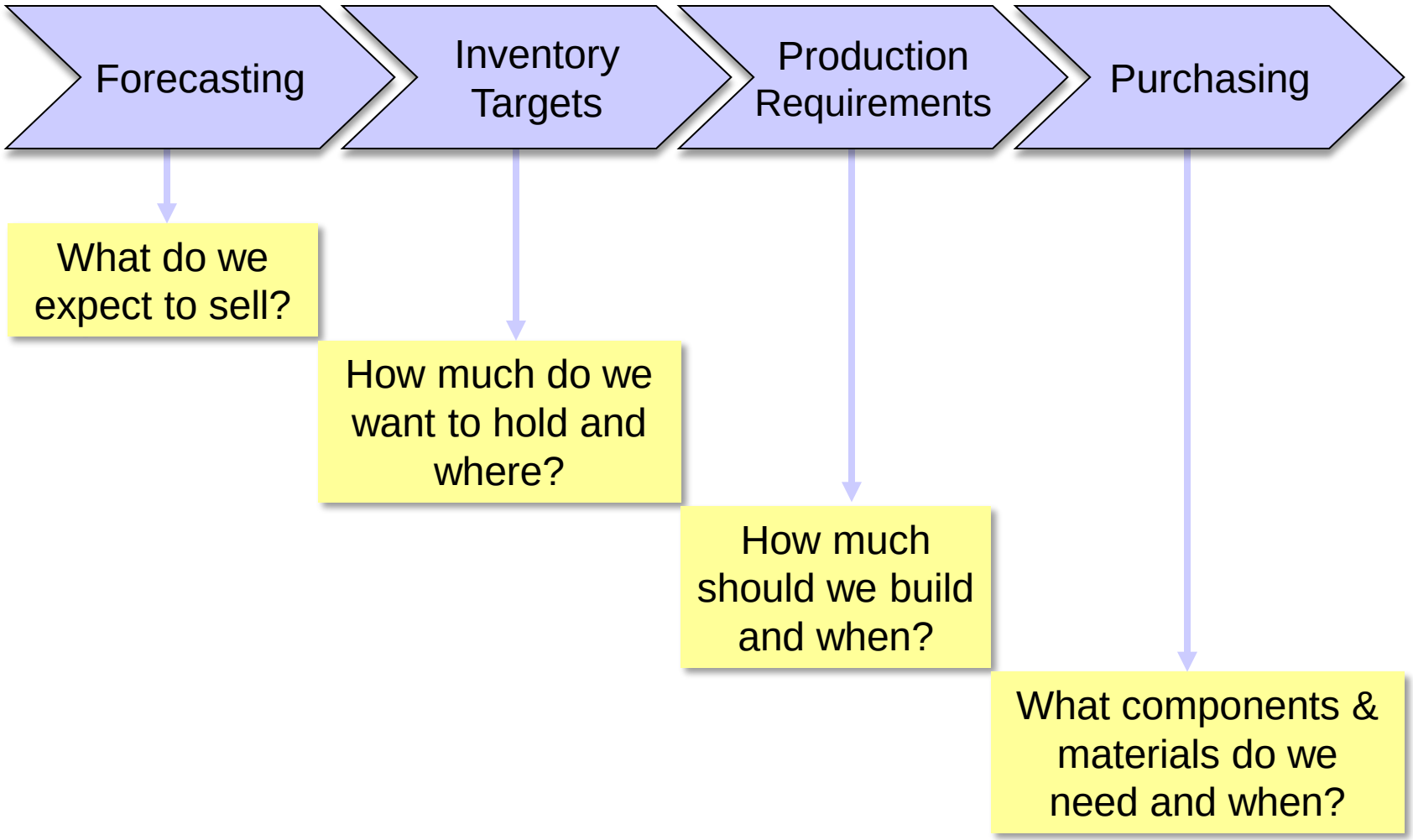
High Level View of Leviton's Supply Chain



Supply Chain Planning is the interface between the Demand Side and the Supply Side



Supply Chain Planning Process (Look Familiar?)



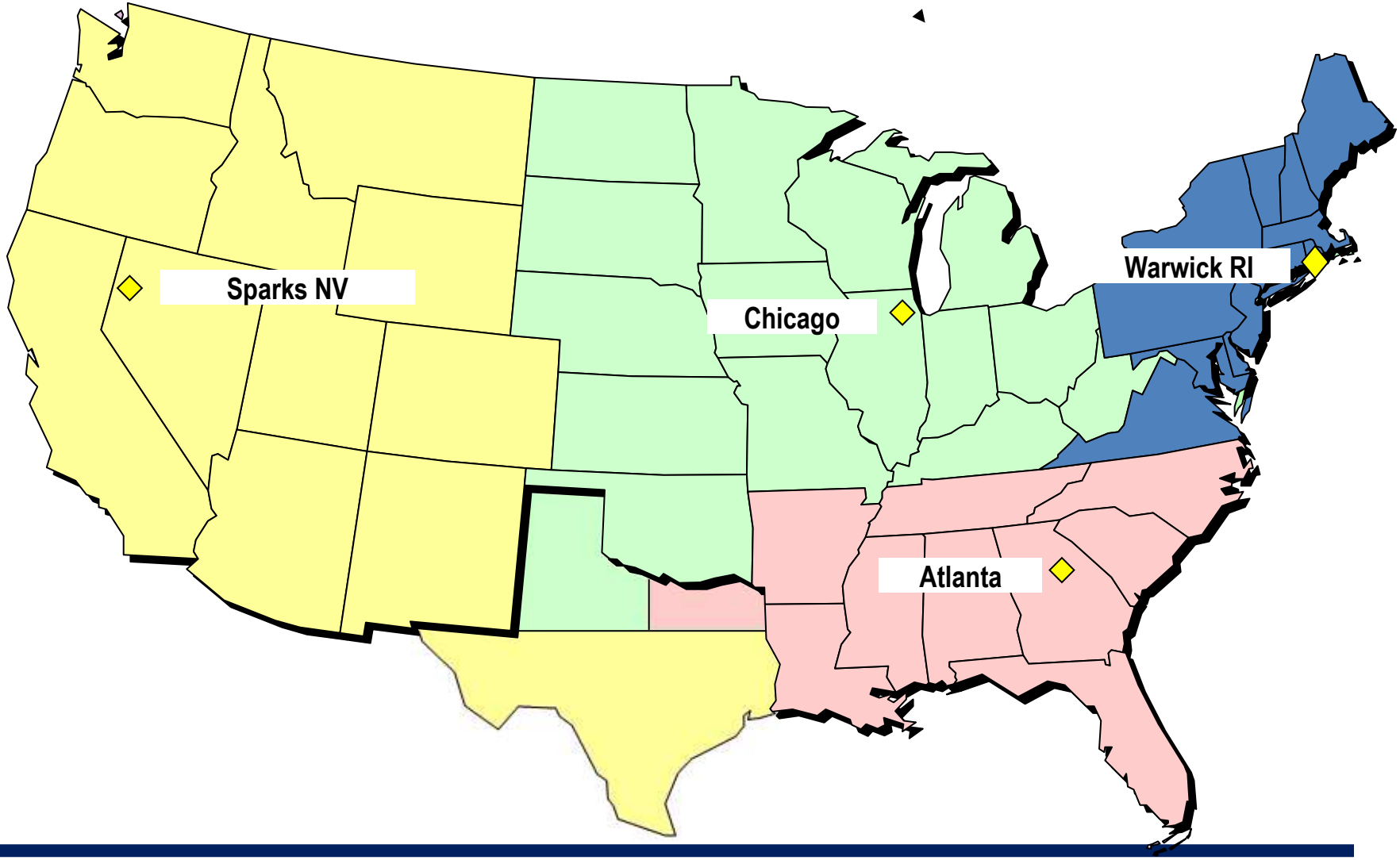
Transition from Traditional Purchasing to Strategic Sourcing

From	To
Many suppliers per commodity	Fewer, strategic suppliers per commodity
Many custom or sole-source items	More standard & multi-source items
Zero-sum-game negotiations	“Win-win” collaboration with suppliers
Discrete Purchase Orders	Blanket Orders; Rolling Forecasts
Unclear objectives & inconsistent communication	Written agreements, clear performance targets, regular business reviews

Objectives from Strategic Sourcing

Reduce Complexity ↓	Reduce Cost ↓	Reduce Risk ↓
• Number of suppliers	• Direct material cost	• Long term relationships
• Number of unique items	• Transactional cost	• Less reliance on custom components & materials
	• Working capital (inventory & payment terms)	

Logistics Network Before Consolidation (June 2008)



Logistics Network after Consolidation

Global Logistics Network Optimization

- Manufacturing
- Distribution

Distribution

USA
- Sparks, NV
- Nashville, TN

Pointe Claire, Quebec
Mexico
- Mexico City
- Camargo

Dubai
Hong Kong, China
Hanover, Germany

Manufacturing

USA
- Morganton, NC
- W. Jefferson, NC
- El Paso, TX
- Bothell, WA
- Portland, OR
- St. Charles, IL

Mexico
- Tijuana (2)
- Camargo
- Jimenez

China
- Dongguan
- Nanjing

- What products should be held in which Distribution Centers?
- Which customers should be served from which DC's?
- How should product be routed from factories to DC's?
- When should we add a new DC? Should we own it or use a 3PL?

Inventory Postponement Project: Problem Statement

- High number of SKUs, including multiple packaging variations of the "same" item
- Highly variable demand, especially on lower-running SKUs
- Periodic demand spikes, e.g., due to customer promotions
- Build-to-forecast, including packaging, in Asia factory
- Long replenishment lead times from Asia to U.S.

Leading to

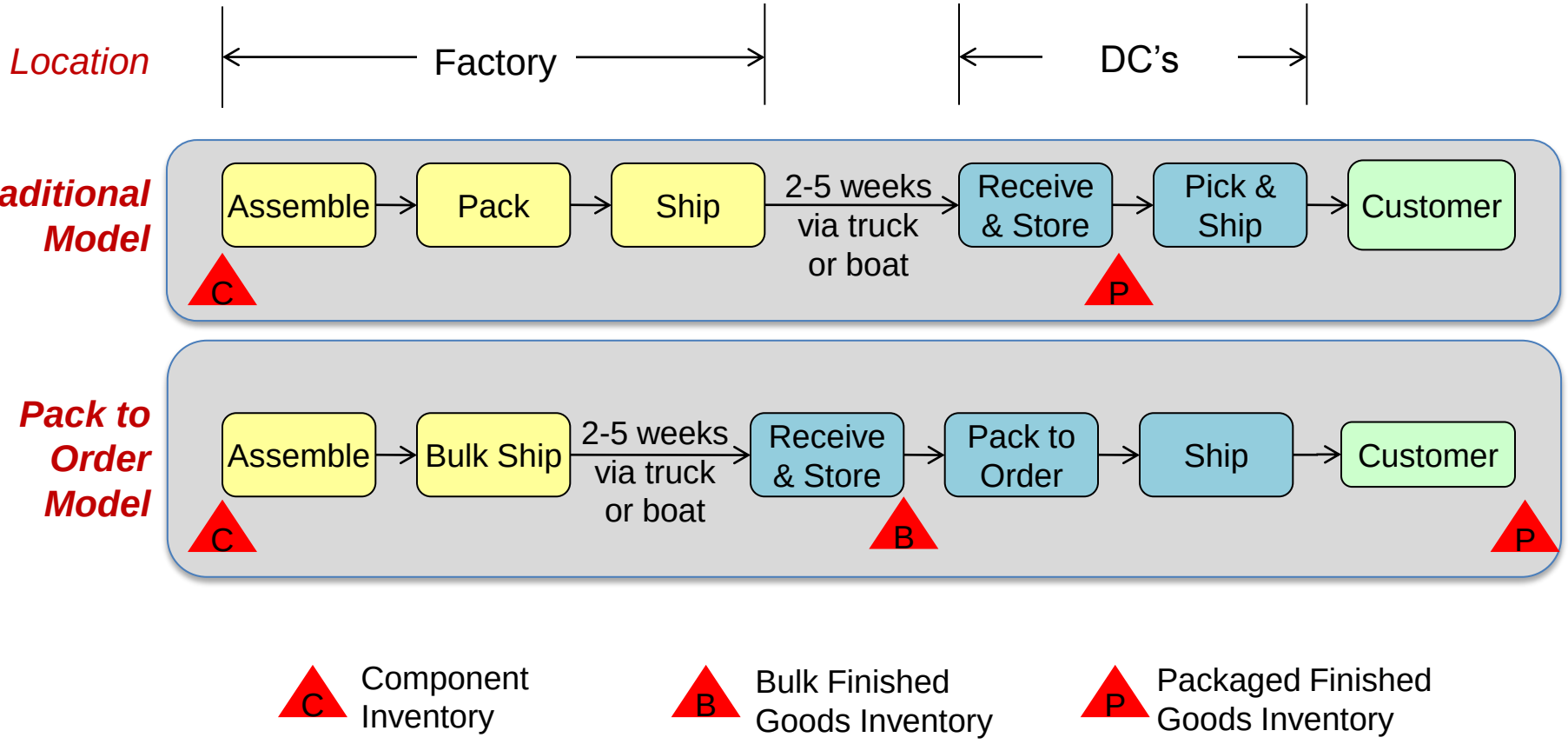
- Frequent stock-outs
- Air freight costs
- Increased manufacturing costs
- Excess inventory

Objectives

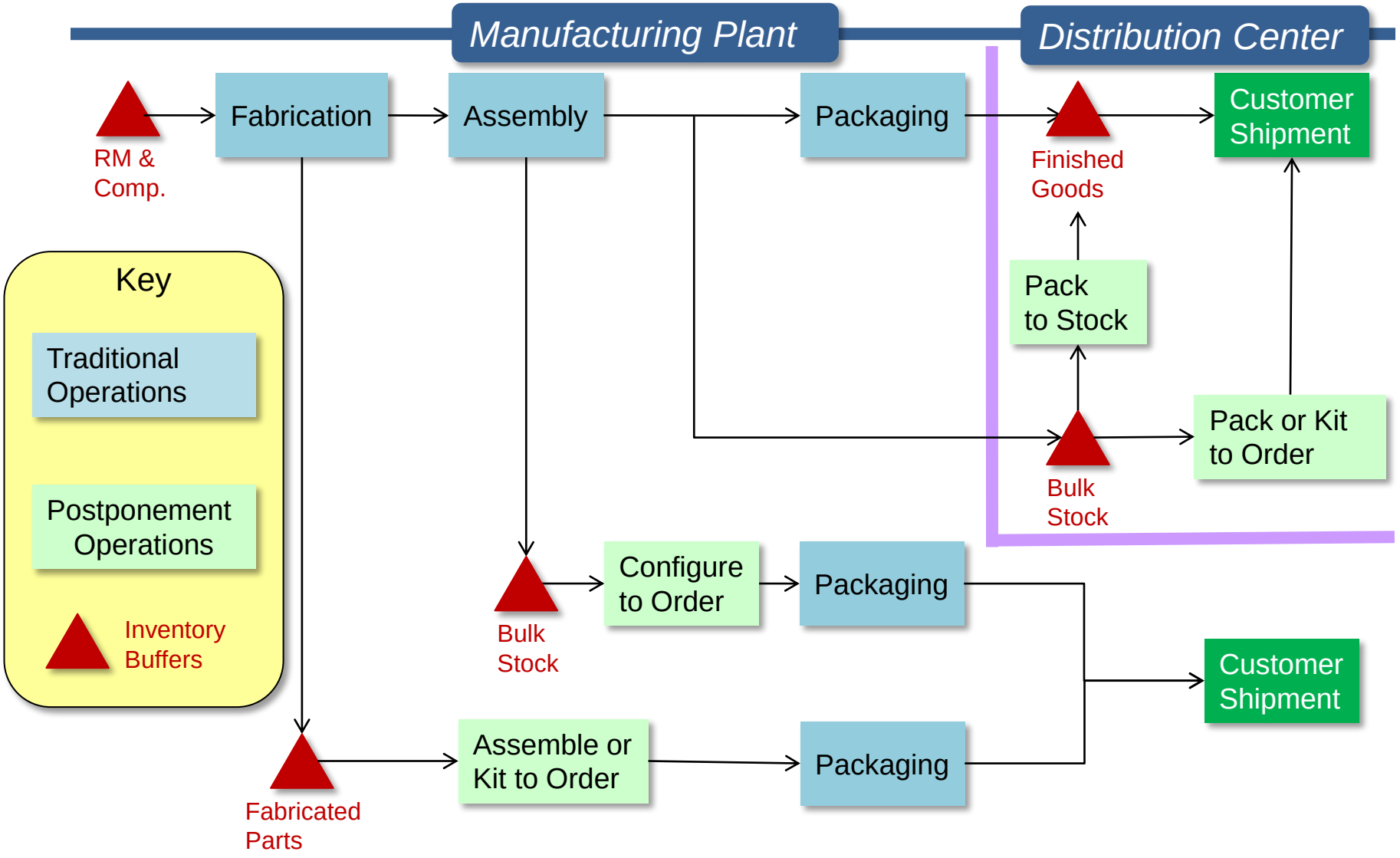
- Increase customer service levels
- Reduce total supply chain cost

Concept: Postponement Strategy

Goal: improve service and reduce costs by shipping bulk (unpackaged) product from the factories to the DCs, and then packaging to order



Variety of Postponement or "X to Order" Models



When / Where does Postponement Make Sense?

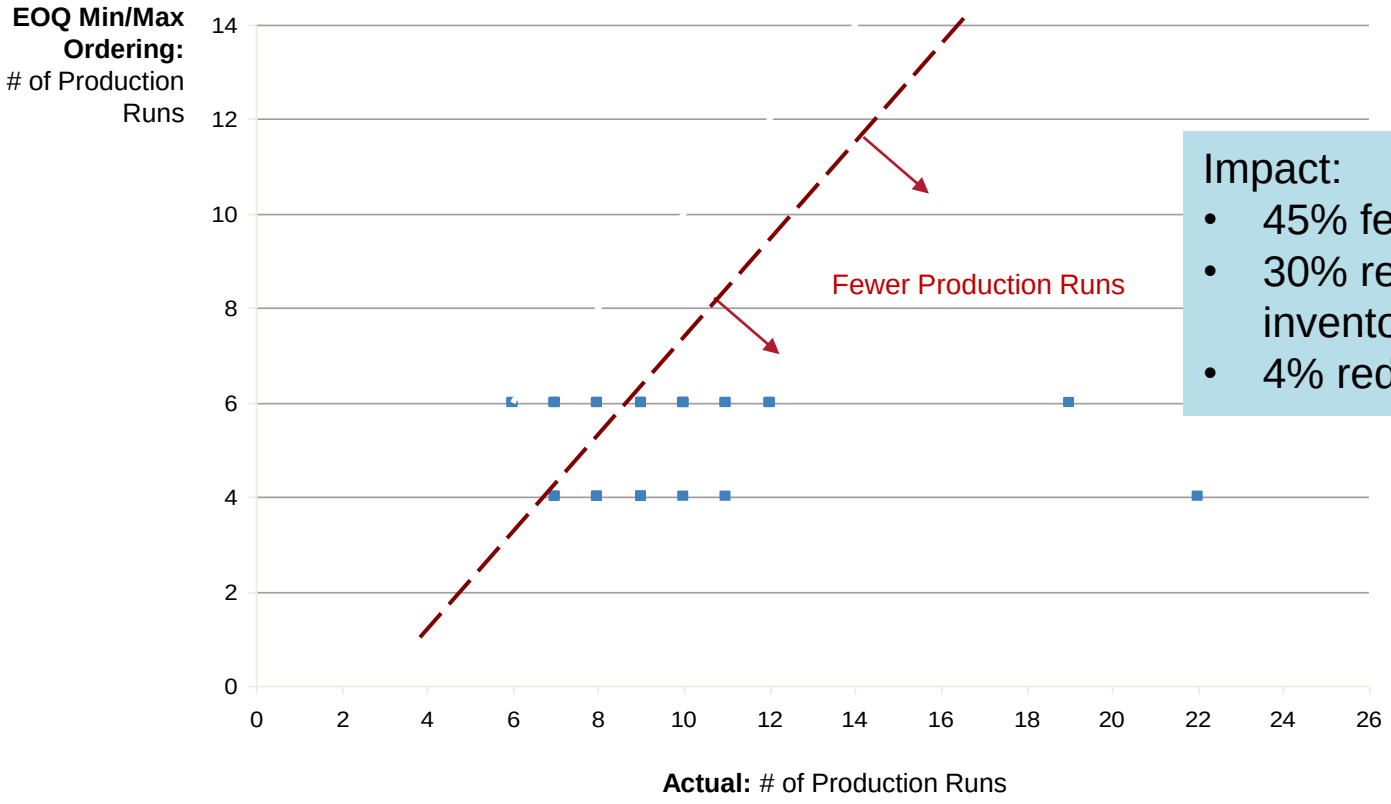
	Postpone	*Don't Postpone*
Cycle Time	• Short (vs. customer service expectations)	• Long
Product variation / fan-out	• Large	• Small
Value-Added ($)	• High	• Low
Demand at Item Level	• Low and/or Unpredictable	• High and/or Predictable
Modularity or Configurability	• High	• Low
Inventory Holding Cost / Obsolescence Risk	• High	• Low

Agenda

- Background
- Inventory Management Basics
- Project Examples
  - Arrow Electronics
  - Leviton Manufacturing
  - REanalyze clients
- Lessons Learned
- Q&A

Example 1: Optimize Production Frequency

Production frequency: Actual vs. EOQ Min/Max

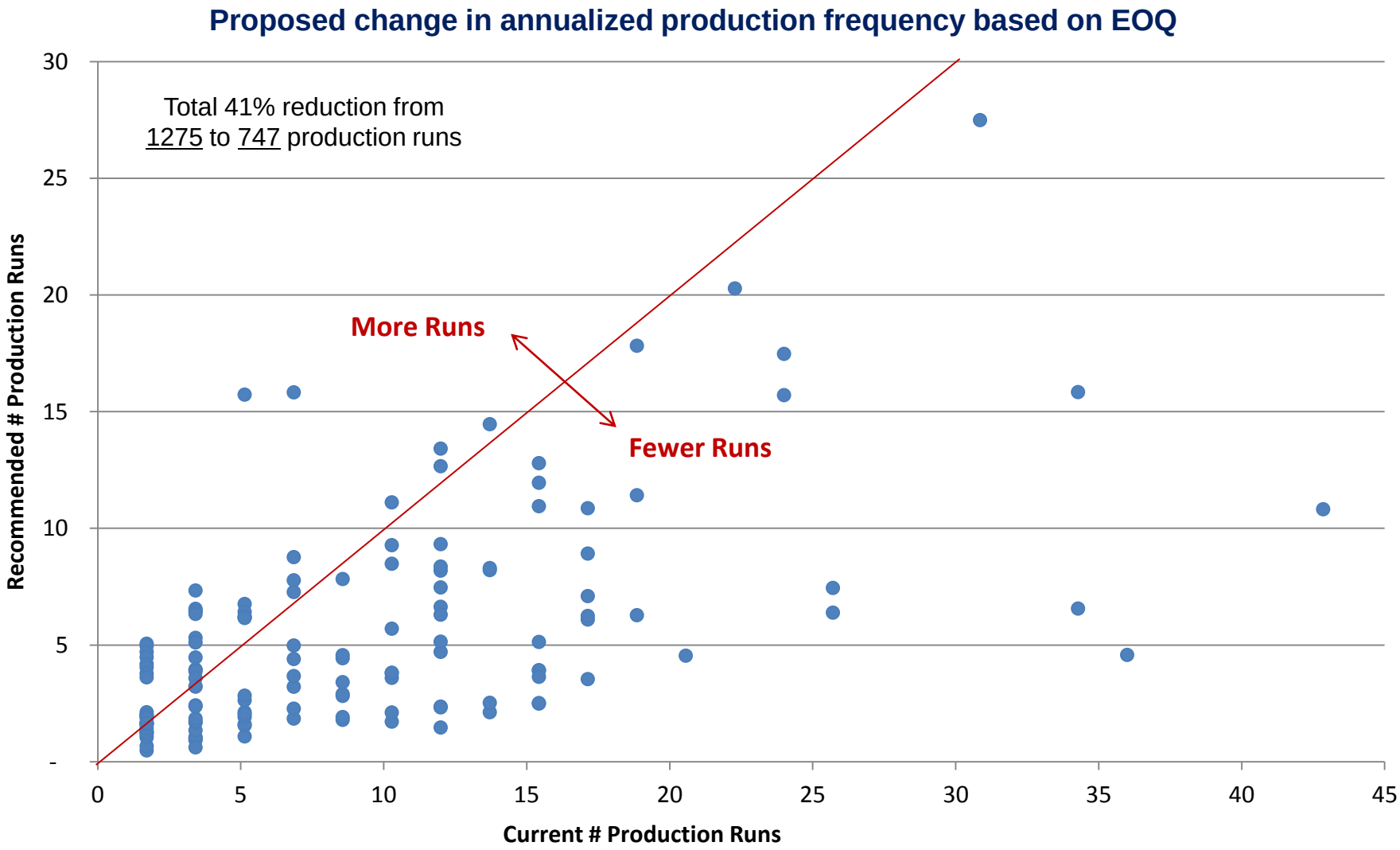


Impact:

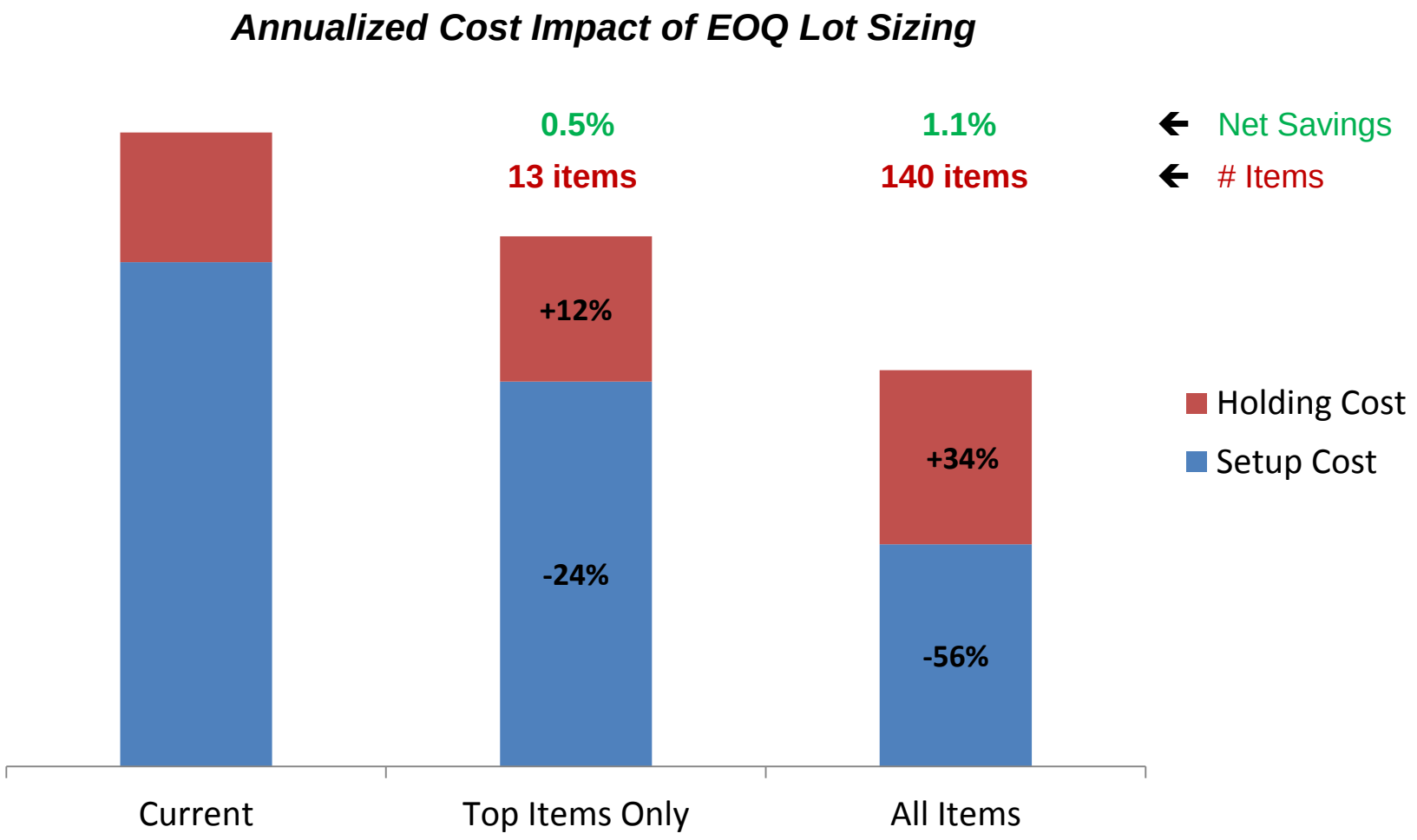
- 45% fewer production runs
- 30% reduction in setup + inventory holding cost
- 4% reduction in unit cost

Recommend producing Class A items 6X per year, Class B/C items 4X per year.

Example 2: Optimize Production Frequency



Example 2: Fewer than 10% of items capture almost half the EOQ benefit



Agenda

- Background
- Inventory Management Basics
- Project Examples
  - Arrow Electronics
  - Leviton Manufacturing
  - REanalyze clients
- Lessons Learned
- Q&A

Lessons Learned

- Supply Chain
  - Always take a total cost approach
  - When making decisions, focus on variable – or better yet – MARGINAL costs
    - What real costs will actually change based on this decision?

- Inventory Management
  - Break the steps down – classify, forecast, inventory targets, purchasing or production requirements
  - Focus on the important items (high $, high risk)
  - Service vs. inventory – moving along the curve (strategy) versus moving the curve (execution & process improvement)
  - Simplify, simplify, simplify (e.g., forecasting algorithms)

Lessons Learned (continued)

- Analytics
  - Analytical skills are increasingly important in supply chain
  - Get all your data in one place (data mart) for decision support
  - Put simple, visual reports and tools in the hands of business users; make them allies and evangelists
  - Work with IT if you can; go around them if you have to
  - Zero tolerance for poor data quality, spreadsheet errors and poor modeling practice

- Communication
  - A picture paints a thousand words (charts & graphs instead of text)
  - Top down, not bottom-up (start with the conclusion or executive summary)

- Management
  - Understand basics of accounting & financial statements and how supply chain improvements affect key financial metrics
  - A mediocre strategy implemented quickly and executed well is BETTER than a great strategy implemented slowly and executed poorly

Lessons Learned for your Career… (from someone who's been there)

- Manufacturing and Distribution companies hire a lot of supply chain professionals
- You have a long career ahead of you
  - Do what you enjoy
  - Don't chase money
  - Try different things
- Make an impact
  - Apply what you learn in school
  - Tie ideas back to a business case – how will you make the company more profitable?
- Look out for #1
  - Nobody cares about your career more than you do
  - Don't expect someone else to manage your career
  - Keep developing and learning

Agenda

- Background
- Inventory Management Basics
- Project Examples
  - Arrow Electronics
  - Leviton Manufacturing
  - REanalyze clients
- Lessons Learned
- Q&A

Thank You!

Rob Ende
President
rende@reanalyzeinc.com
631-807-2339