



Arrow Electronics Uses Simulation Modeling to Improve Inventory Performance and Customer Service

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Agenda

- **Arrow Electronics background**
- **History of inventory modeling at Arrow**
- **Simulation modeling approach**
- **Sample projects and business impact**
- **Lessons learned and future direction**

Arrow Electronics, Inc. is...

**A global provider of products,
services and solutions to industrial
and commercial users of
electronic components and
computer products**

Arrow at a Glance



| | |
|-------------------------|--|
| Founded: | 1935 |
| Publicly Traded: | (ARW) New York Stock Exchange |
| Web Site: | www.arrow.com |
| 2006 Sales: | \$13.6 billion |
| Employees: | 11,400 |
| Locations: | More than 250 sales facilities in over 50 countries Over 40 warehouses, distribution and valued added centers worldwide |
| Corporate HQ: | Melville, New York |
| Customers: | More than 130,000 |
| Suppliers: | Nearly 600 |

Diversified Customer Base

No single customer represents more than 2% of revenue

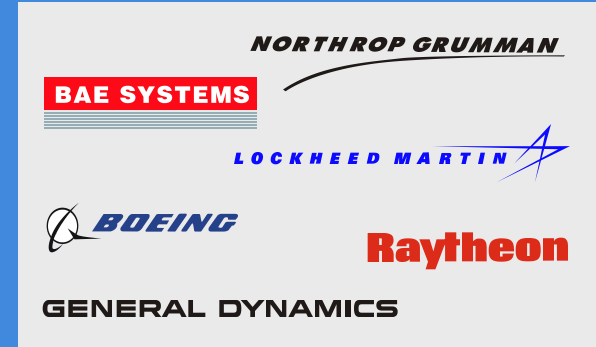
Wireline and Wireless Networking Infrastructure



Medical Imaging, Instrumentation and Scientific Testing



Military and Aerospace



Electronic Manufacturing Services



Machine Tools and Industrial Controls



Enterprise Computing



Broad Supplier Line Card

Electronics Components Sales ~75% Semiconductor,
~25% PEMCO (Passive, Electro-Mechanical, Connectors)

Top Semiconductor Suppliers

- Altera
- Analog Devices
- Avago
- Fairchild
- Freescale
- Infineon
- Intel
- Linear Technology
- Microchip
- Micron
- National
- NXP (formerly Philips Semi)
- ON Semiconductor
- ST Microelectronics
- Texas Instruments

Top PEMCO Suppliers

- AVX
- Bourns
- Epcos
- FCI
- ITT
- Kemet
- Littelfuse
- Molex
- Samtec
- Tyco
- Vishay

About \$1.5B Inventory at end of 2006*

Why?



Supply uncertainty

- Lead time
- Lead time variability
- On-time delivery

Internal economics, processes & systems

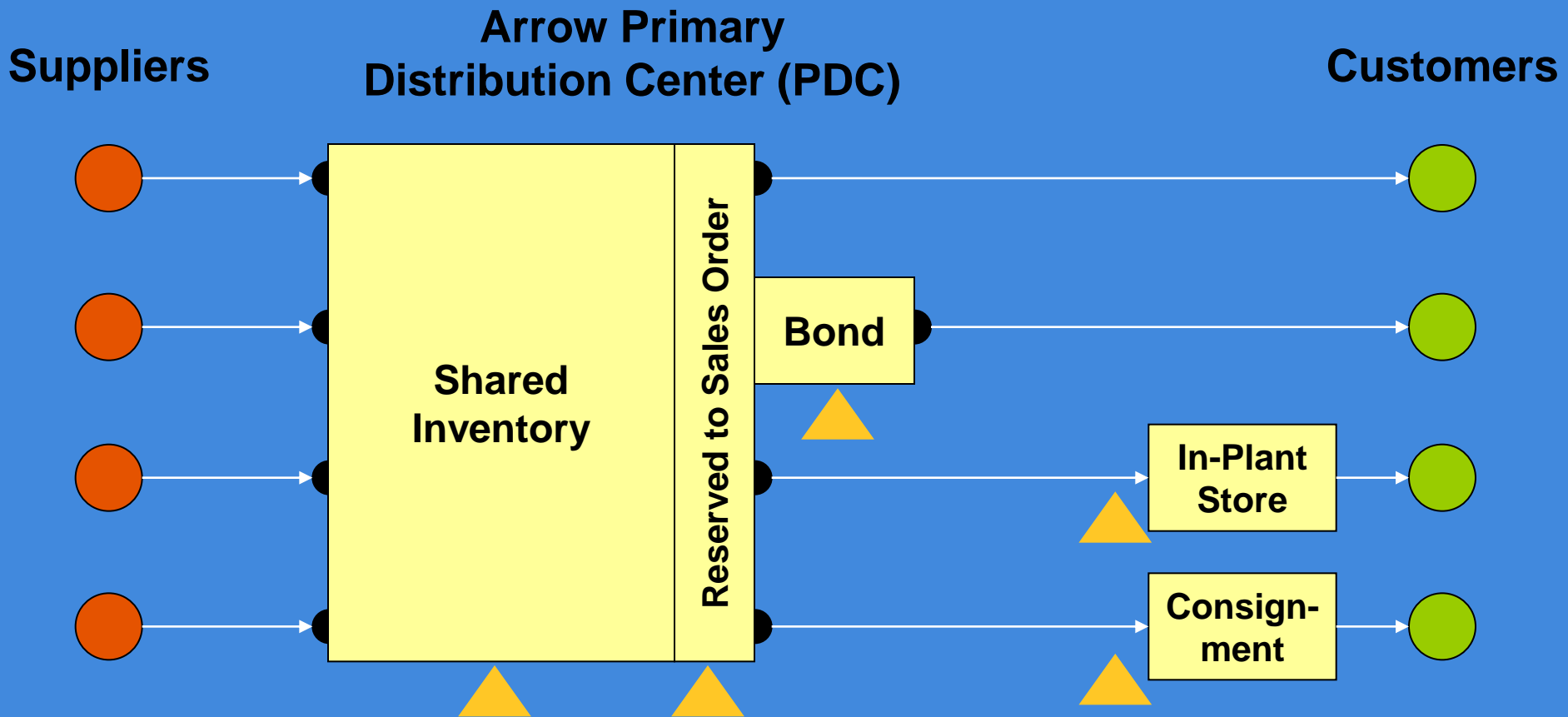
- Stocking levels
- Economic order quantities
- Minimum order quantities
- Volume discounts
- Physical logistics & value-added cycle time

Demand uncertainty

- Consumption variability
- Forecast error
- Order cancellations
- Support for VMI programs

* Excluding Computer Products

Basic Supply Chain Structure: Multiple Inventory Buffers



Modeling Background

- **No formal modeling effort prior to 2003**
 - Pockets of spreadsheet modeling & analysis in various groups
- **Supply Chain Optimization team created in North America following Manugistics implementation in 2003**
 - Concept: analytical experts – “mechanics under the hood”
 - Initial focus: tuning forecast algorithms and system parameters
- **Team became “global” in 2005**
 - Majority of work continues to be N.A.-focused
- **Focus has shifted to more complex modeling**
- **Currently 2 modelers (Supply Chain Engineers) as part of 12-person Supply Chain Optimization team**

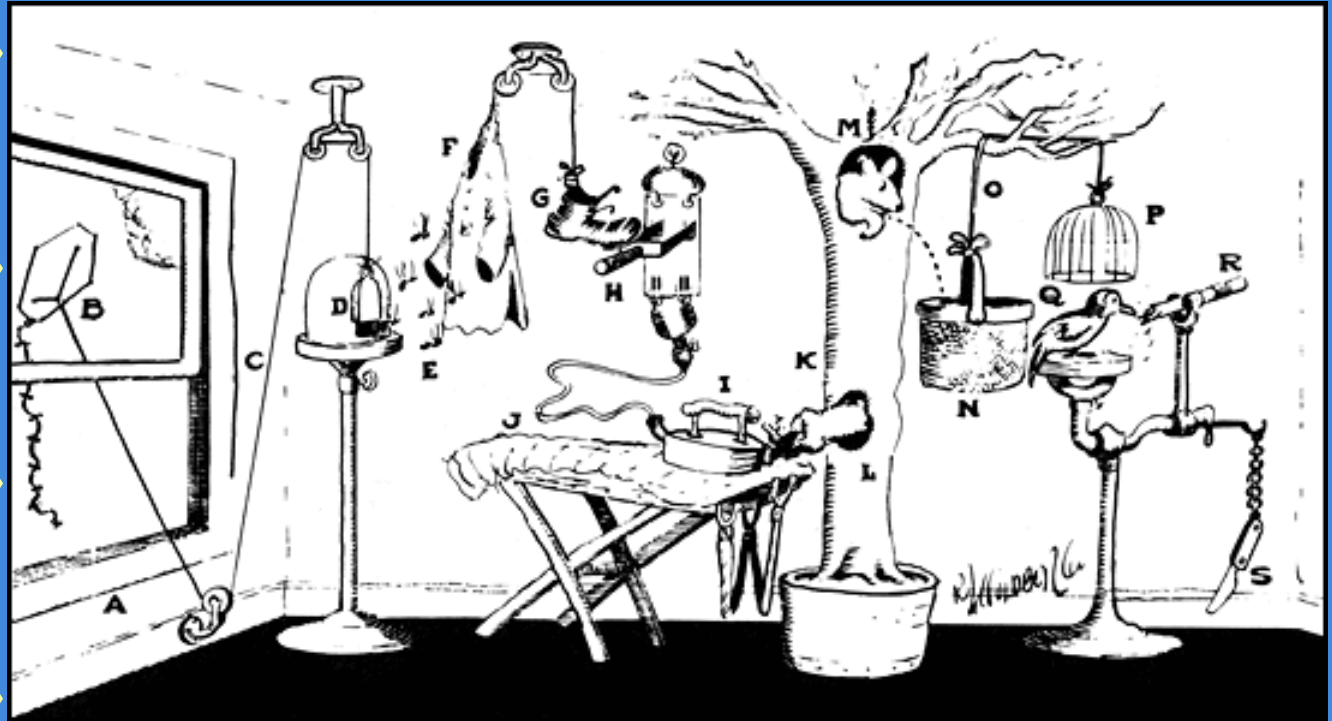
Our Problem...

Forecast Algorithms

Safety Stock Settings

Purchasing Rules

Forecast Accuracy



Inventory Turns

?

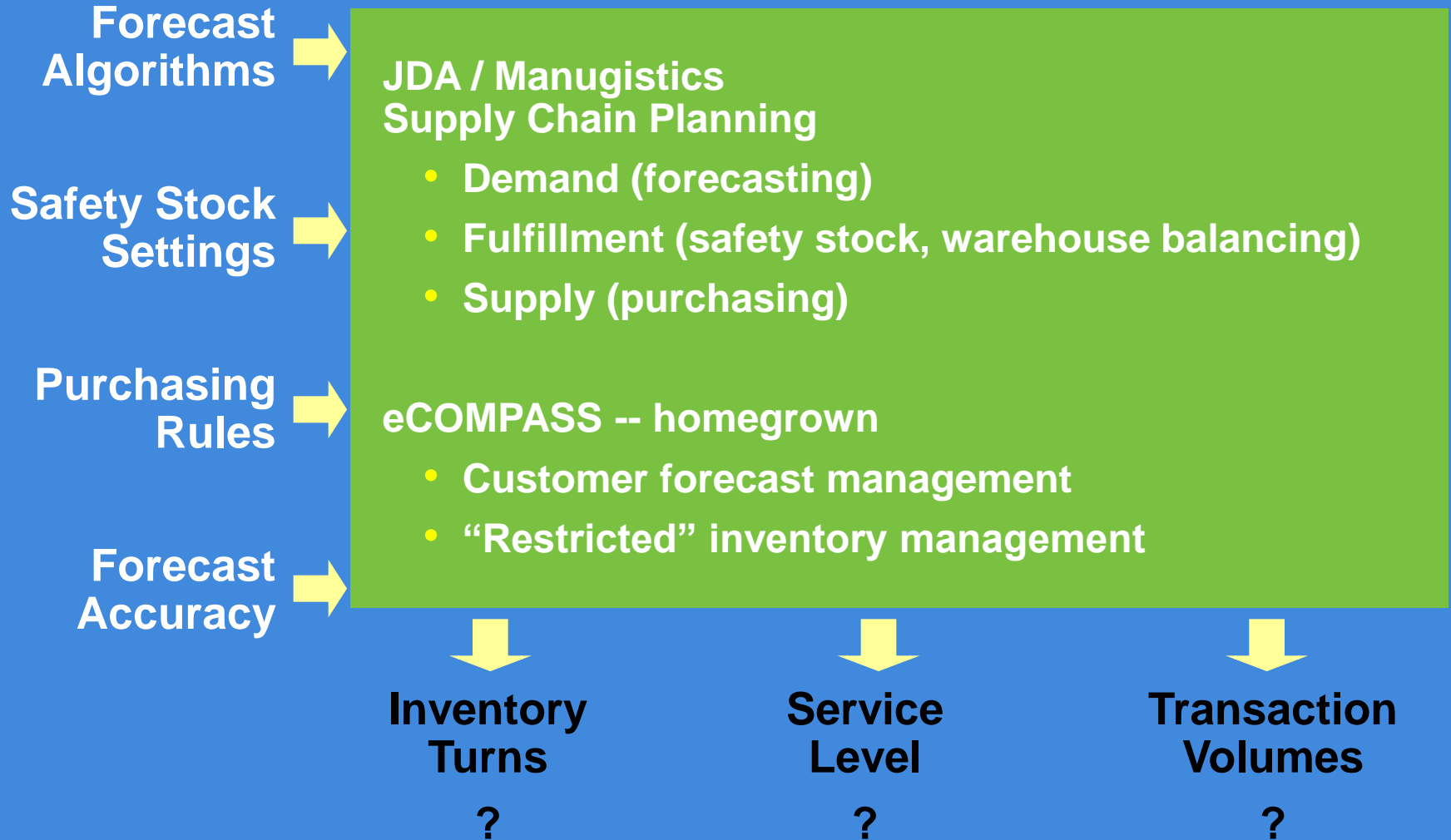
Service Level

?

Transaction Volumes

?

Our Problem...

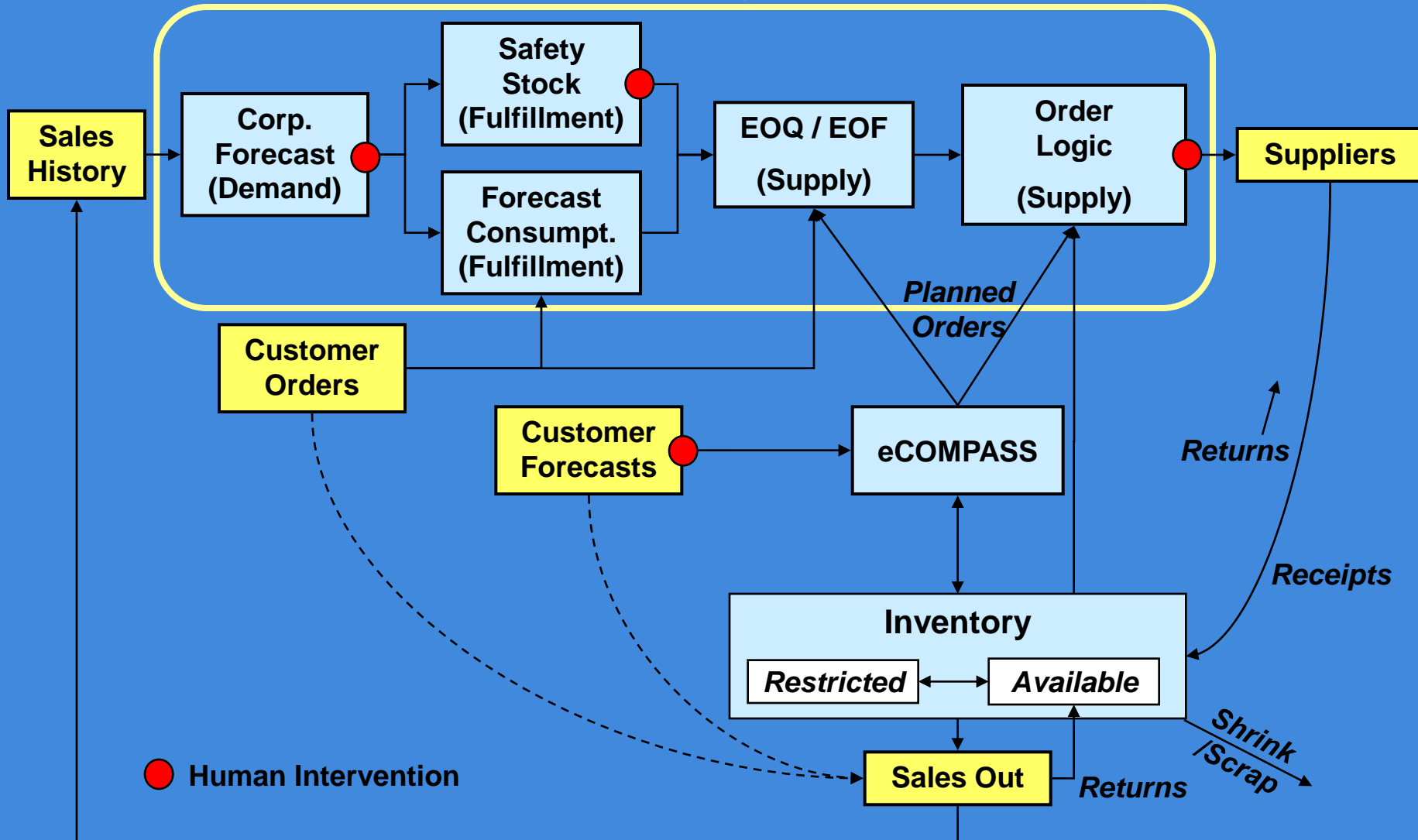


Inventory Simulation Model: Project Objectives

- **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

JDA (Manugistics) Supply Chain Planning

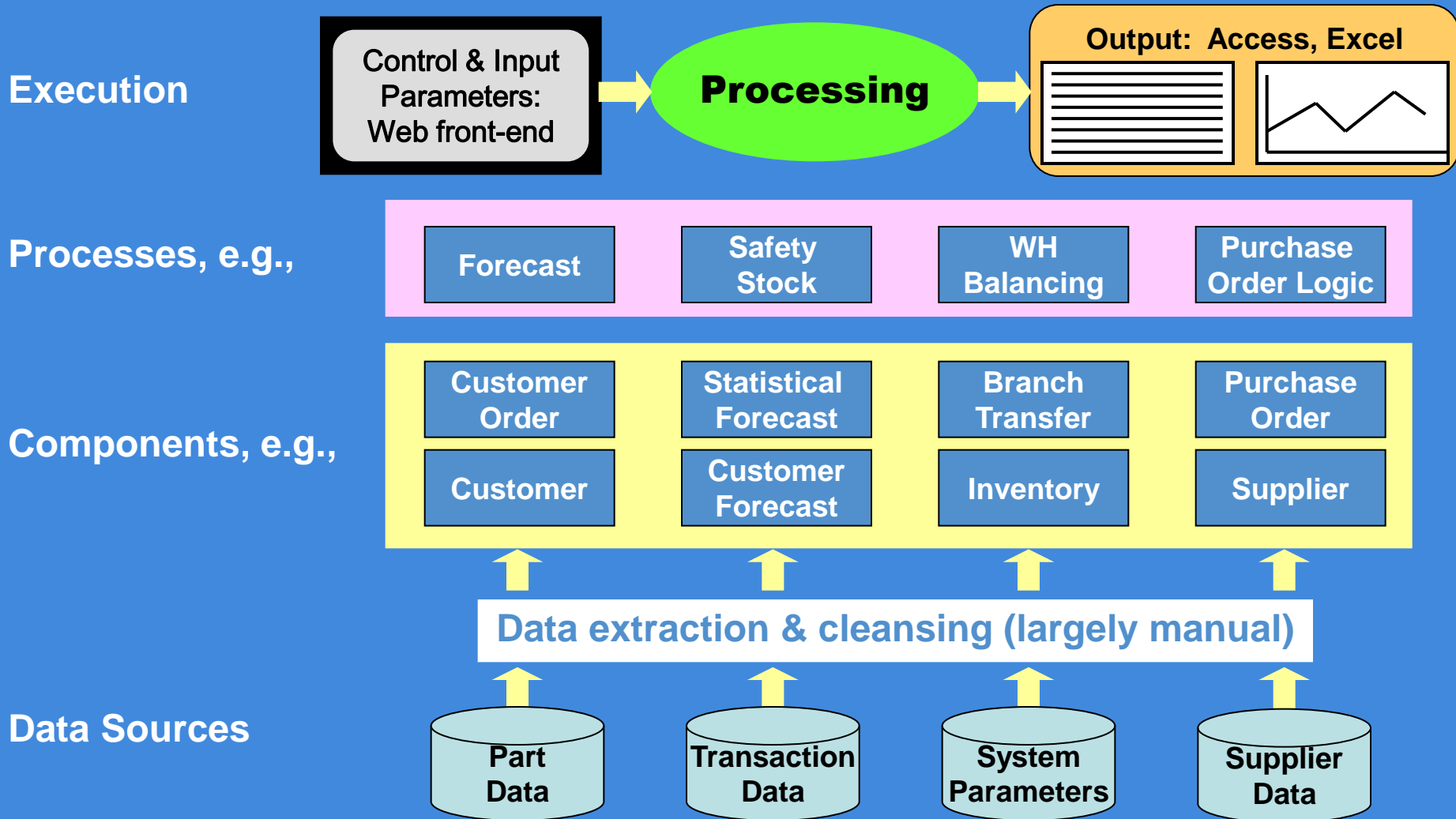


Modeling Approach

- Progressed from Access / Excel / VBA prototype to custom-coded Java model
- Deterministic model
 - “Roll back the clock” -- simulate 6-12 months history using actual customer demand as input
 - Experience has showed minimal value from stochastic model with statistical demand distributions
- Typically run sample of 500-1000 parts
- “Calibration” parameters” for human intervention
- Validate against actual results (e.g., Sales, inventory, fill rate)
 - Directionally correct
 - Differences from actual are explainable
 - MOST IMPORTANT: proper sensitivity to parameters

Architecture is Modular and Flexible

Tailor model to fit needs of each analysis



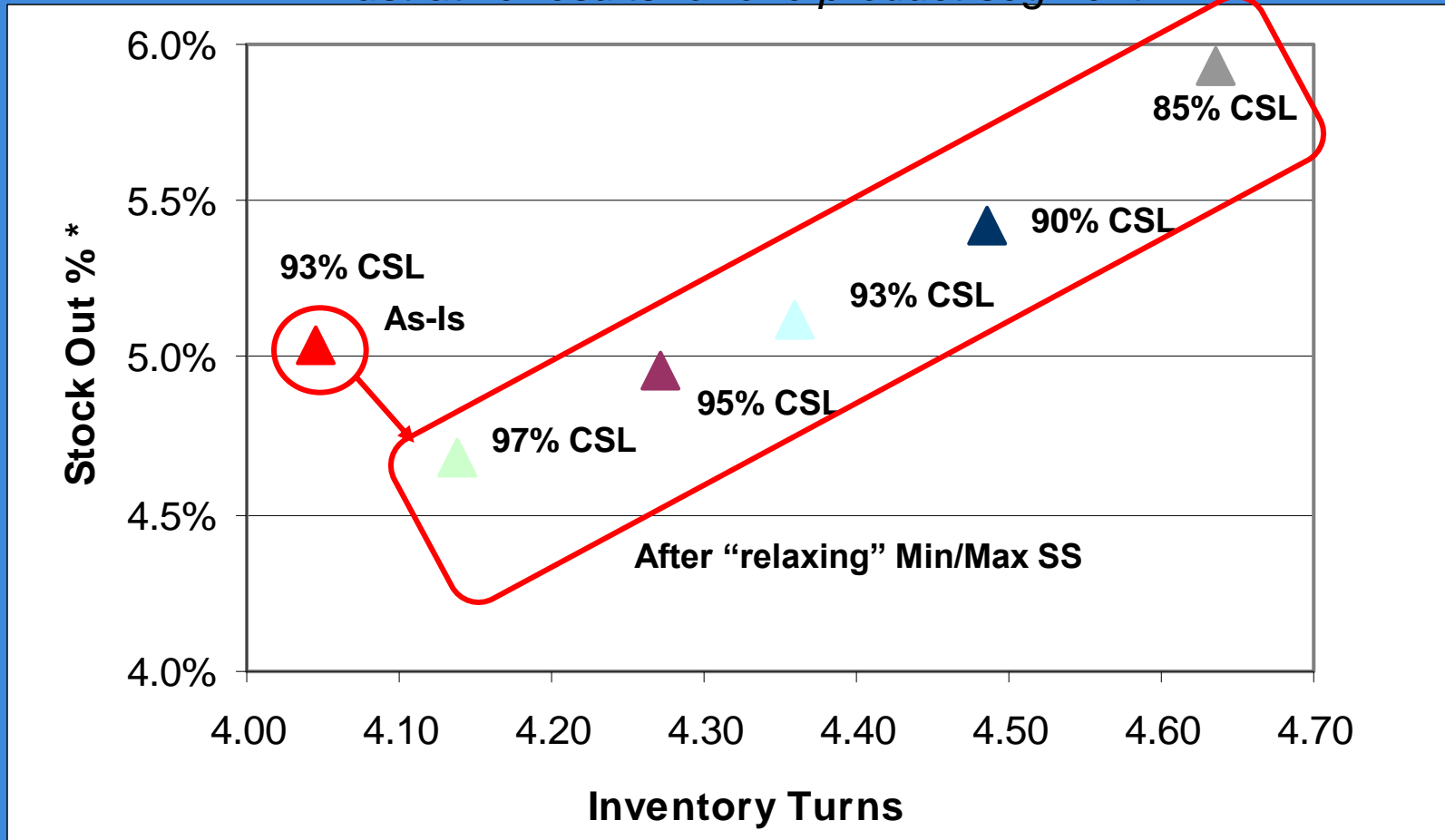
Sample Projects

- **Safety stock parameters and forecast adjustments**
- **Change order reduction**
- **Warehouse balancing**
- **Customer-restricted inventory management**

Safety Stock Parameters

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

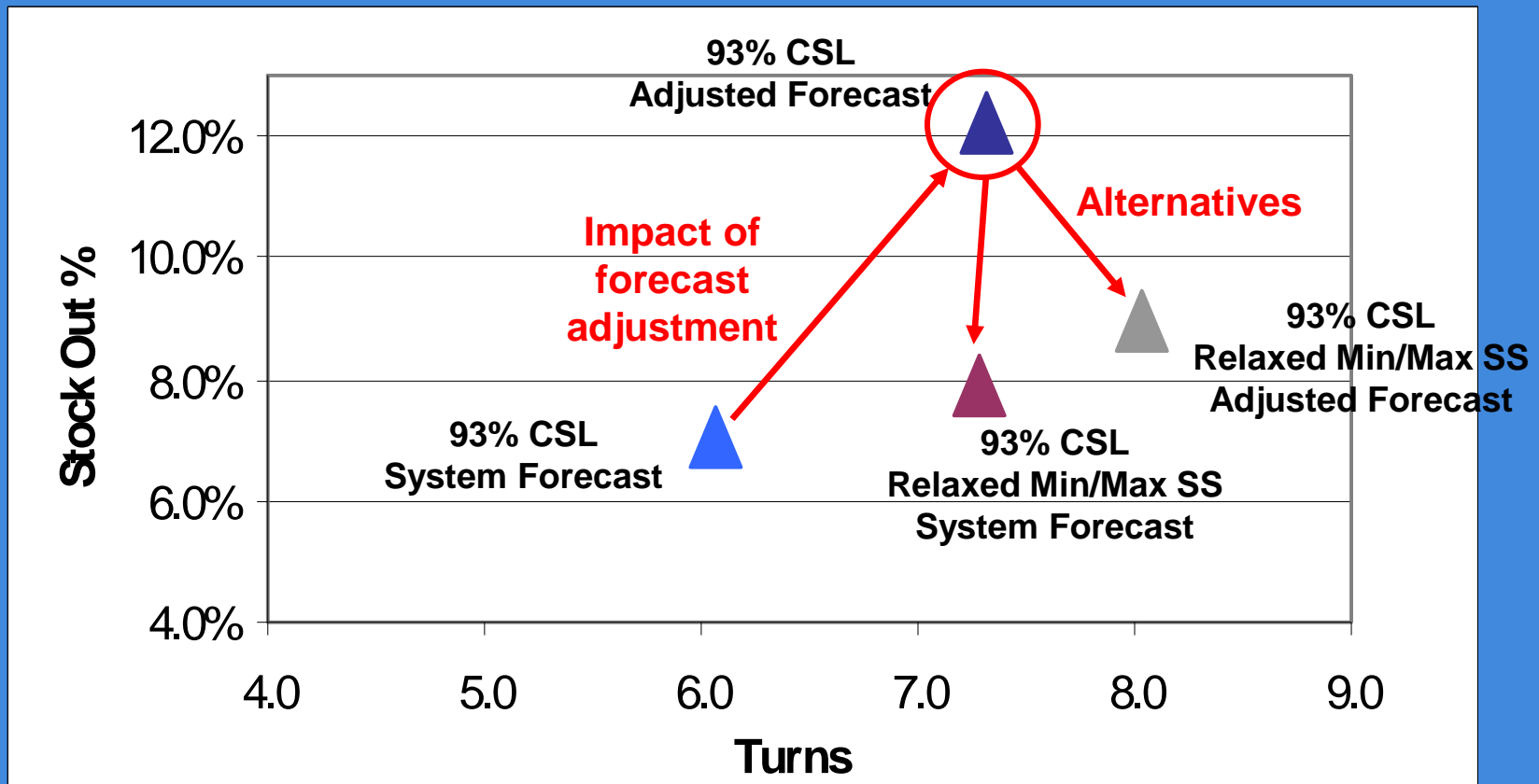
Illustrative results for one product segment



Safety Stock Parameters:

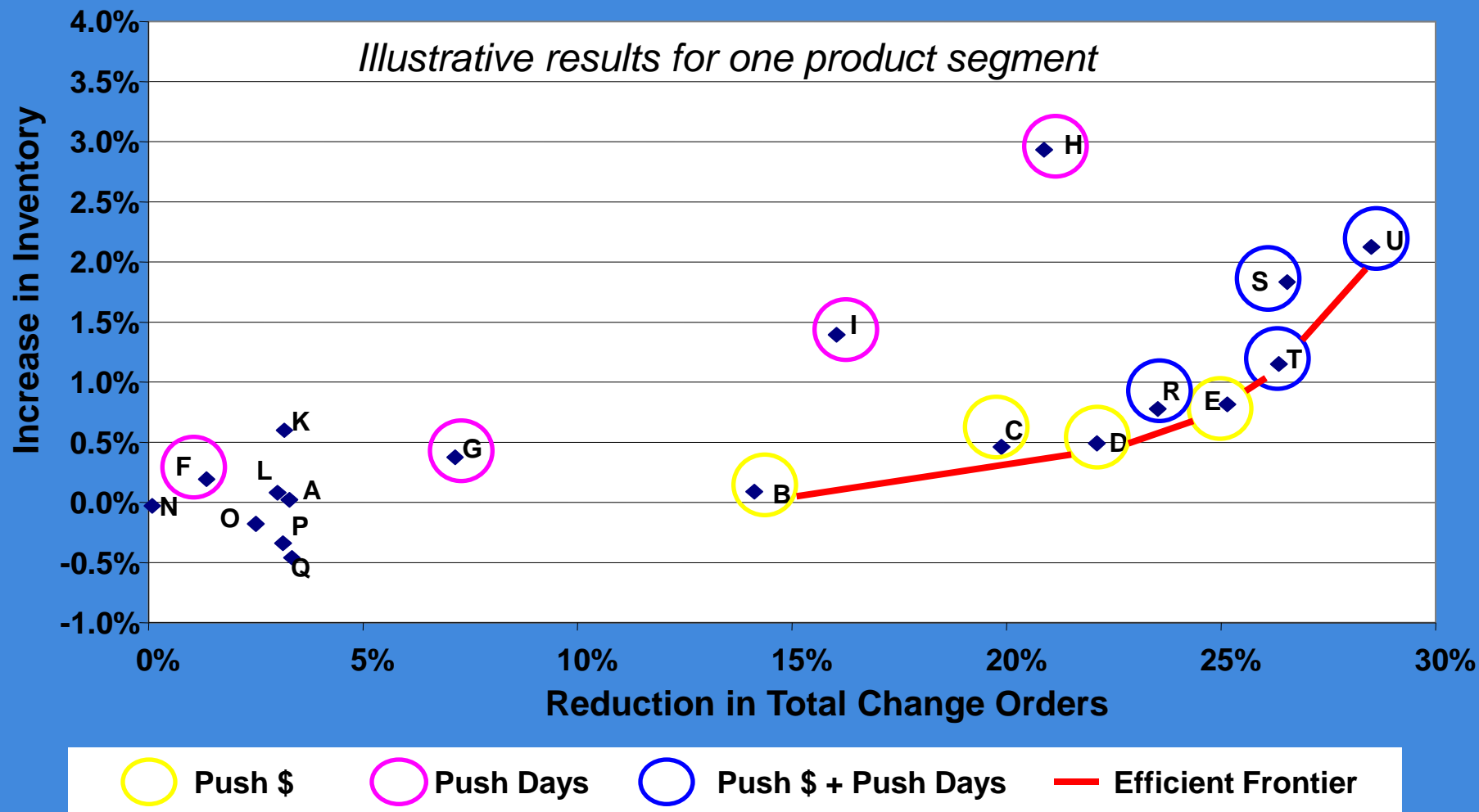
Reductions to system forecast helped turns but hurt service levels; can improve turns AND service by relaxing Min/Max Safety Stock

Illustrative results for one product segment



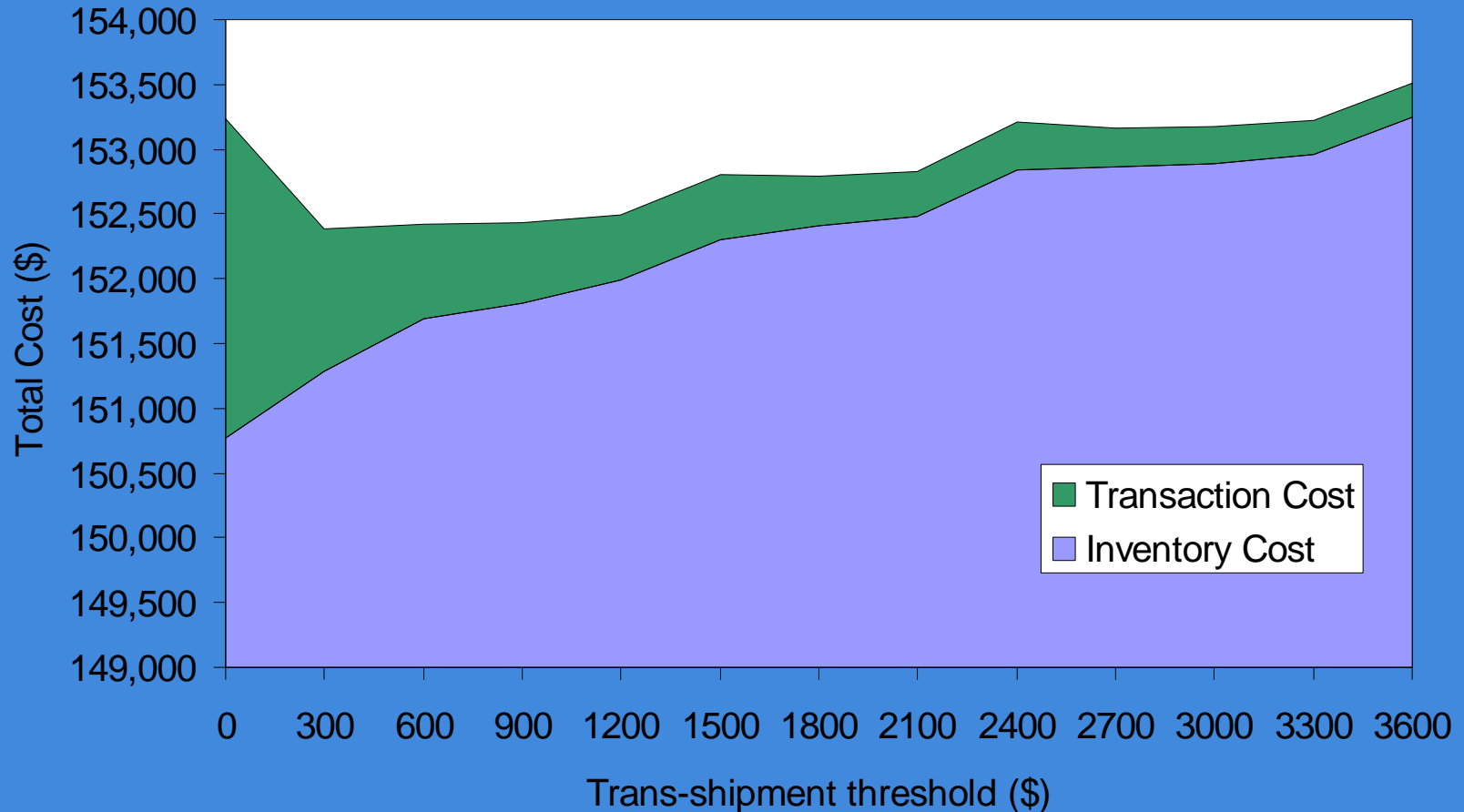
Change Order Reduction

Identify purchasing parameters to reduce change order volume with minimal inventory impact



Warehouse Balancing

Validate network strategy; set proper trans-shipment threshold to minimize total cost



Current Focus: eCOMPASS / Customer Restricted Inventory Management

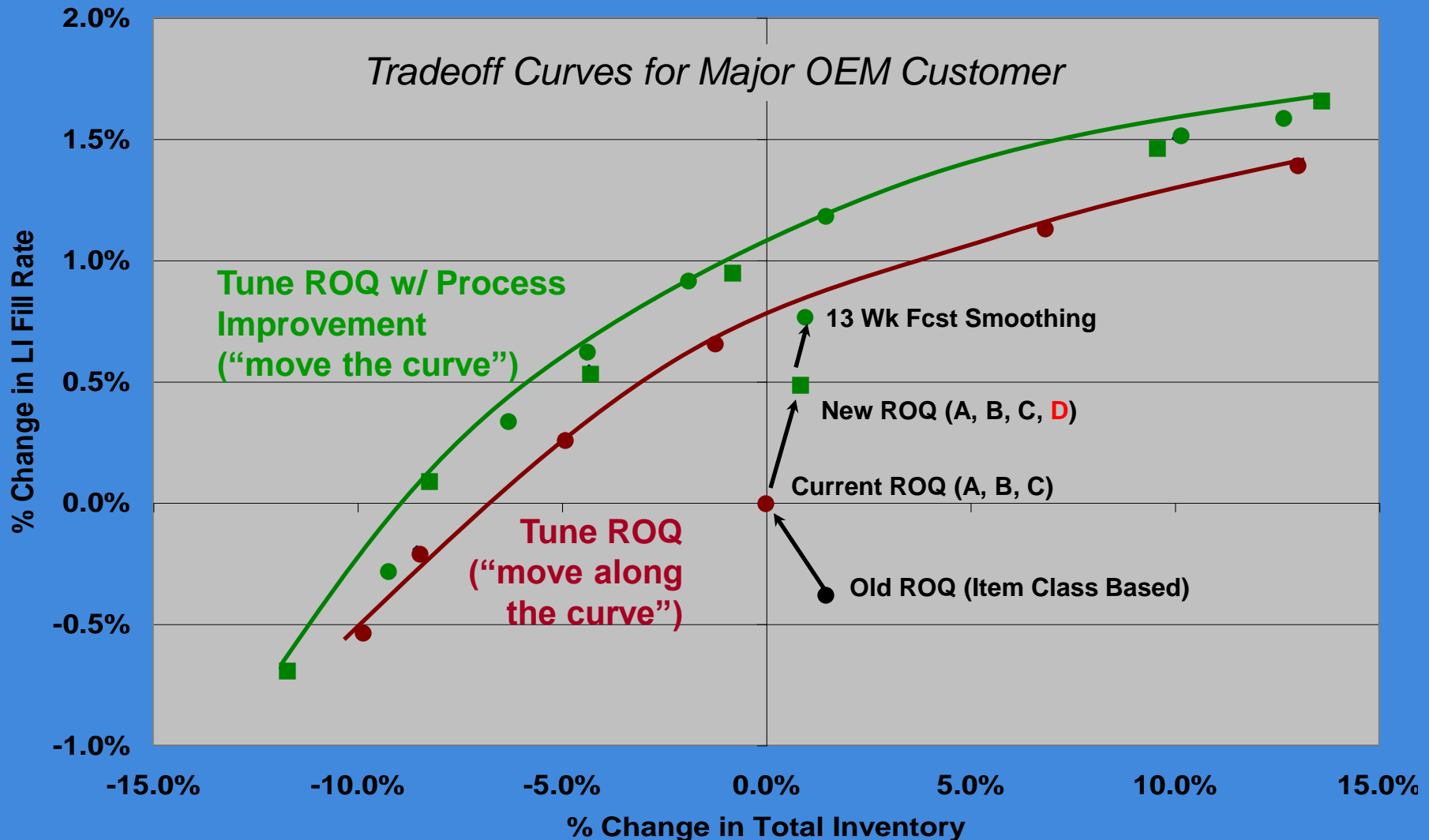
Background

- Poor service levels and inventory turns with a major OEM customer
- Joint Arrow / Customer process improvement team identified potential process & system enhancements
- SC Optimization team asked to evaluate options and quantify potential impact

Objectives

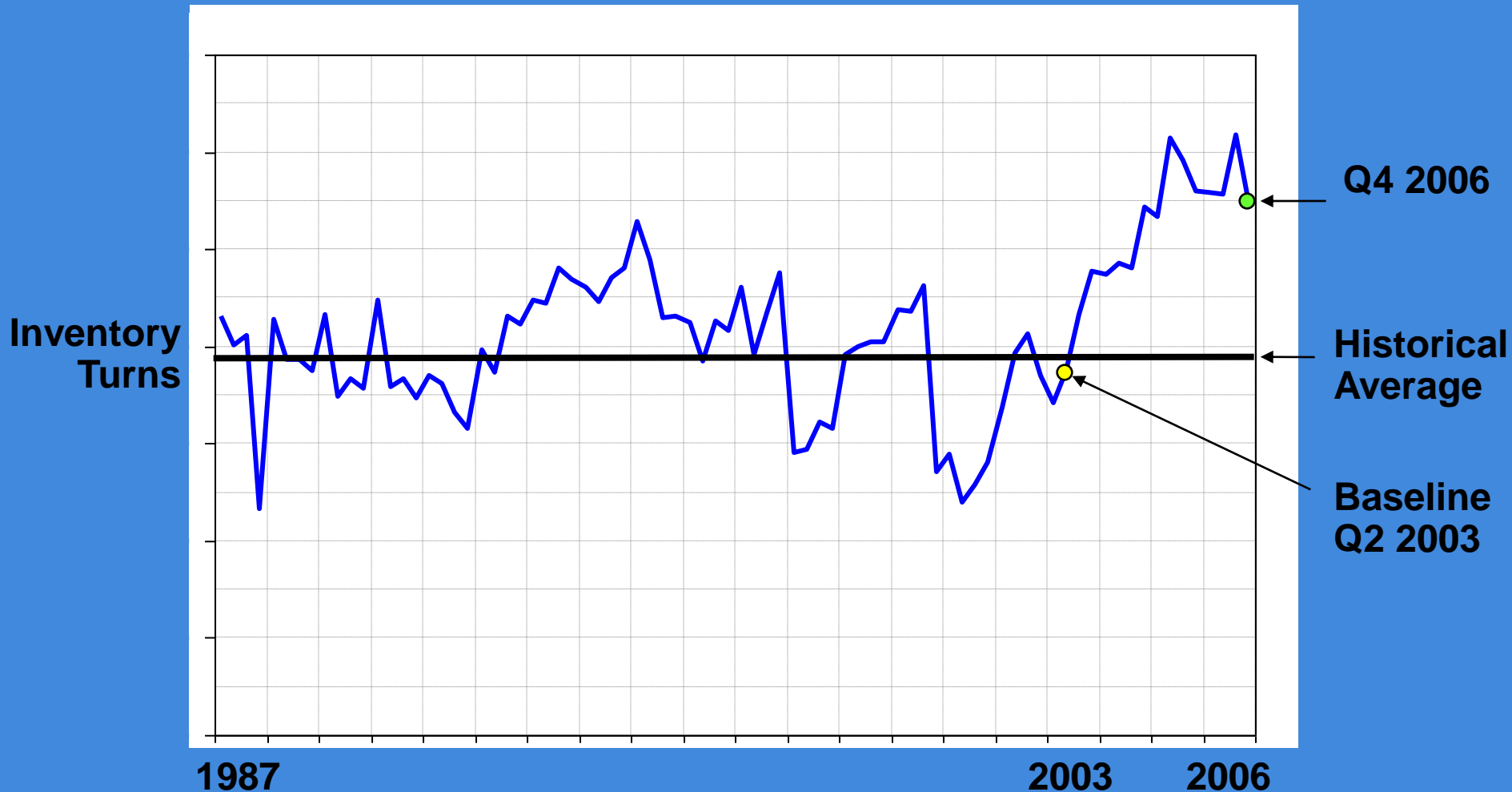
- Simulate demand patterns and eCOMPASS inventory logic
- Evaluate parameter settings and logic enhancements and identify “optimal” alternatives
- Quantify potential inventory and customer service impact
- Quantify impact of customer forecast accuracy
- Develop a reusable tool that can be applied to other customer engagements

Restricted Inventory Management: Significant Service & Inventory Improvement Opportunities



Impact: Inventory Turns Trend

Modeling & analysis has played a key role in achieving business results

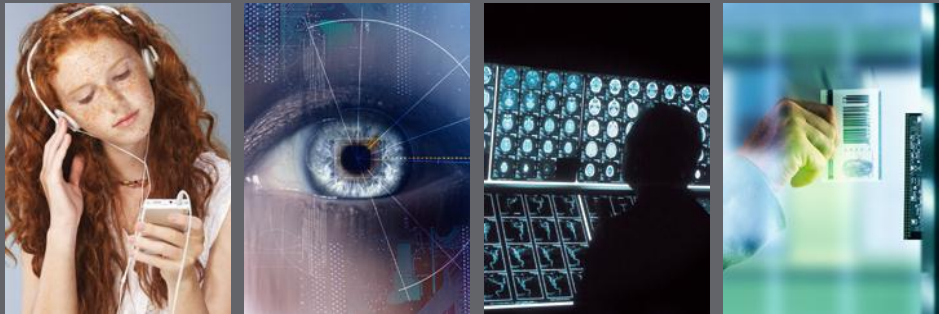


Lessons Learned

- Hire smart people – they can learn what they need to know
- Internal development vs. 3rd party support
 - We are better than we give ourselves credit for
- Modeling approach
 - Modular and reusable
 - Stochastic vs. deterministic?
 - Must model sufficient complexity
- It always takes longer than you expect
 - Data cleansing, validation, calibration, etc.
- Stay close to the business

Future Modeling Possibilities: Expand Focus Beyond Inventory

- **Logistics Network Optimization**
- **Price Optimization**
- **Simulation for Lean Six Sigma Process Improvement**



Thank You!

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