SMARTLOG - workshop

June 8, 9, 2005

# Optimizing the Supply Chain

## Session 2

Jeremy F. Shapiro

MIT/Slim Technologies

# Agenda – Session 2

## Three Case Studies of Supply Chain Network Optimization

- Distribution network redesign of a retailing company
- Worldwide sourcing in an industrial chemicals company
- Post-merger consolidation of two pet foods companies

# SLIM

## Slim Technologies Software Applied in Three Cases

www.slimcorp.com

Modeling capabilities

- Optimize single period or multi-period models
- Locate new facilities and close existing facilities
- Model multi-stage processes at manufacturing and distribution facilities
- Model fixed and variable costs, economies of scale, sole sourcing of markets
- Model distribution networks with multiple transport modes
- Maximize profits or minimize costs

Easy-to-use Windows interfaces

Data Integration and Management

- Input/output files in MicroSoft Access
- Extensive management reports
- Data utilities to create input files
- Geographical mapping of inputs and outputs

# Building an Optimal Logistics & Distribution Network Strategy

CLM 2004
Vision. Velocity. Value.
October 3-6, 2004
Philadelphia, PA

*Presented By:*

- Jeremy Shapiro, SLIM Technologies
- Dan Sobbott, SLIM Technologies
- Todd Dudas – IKEA

***This presentation outlines the value of network optimization to achieve highest customer service at lowest total cost. A case study will outline key challenges, benefits and ROI opportunities in conducting a network strategy to manage business growth, maximize asset utilization and minimize capital investment.***

# Case Study: IKEA



## *IKEA Develops 5-year Distribution Strategy*

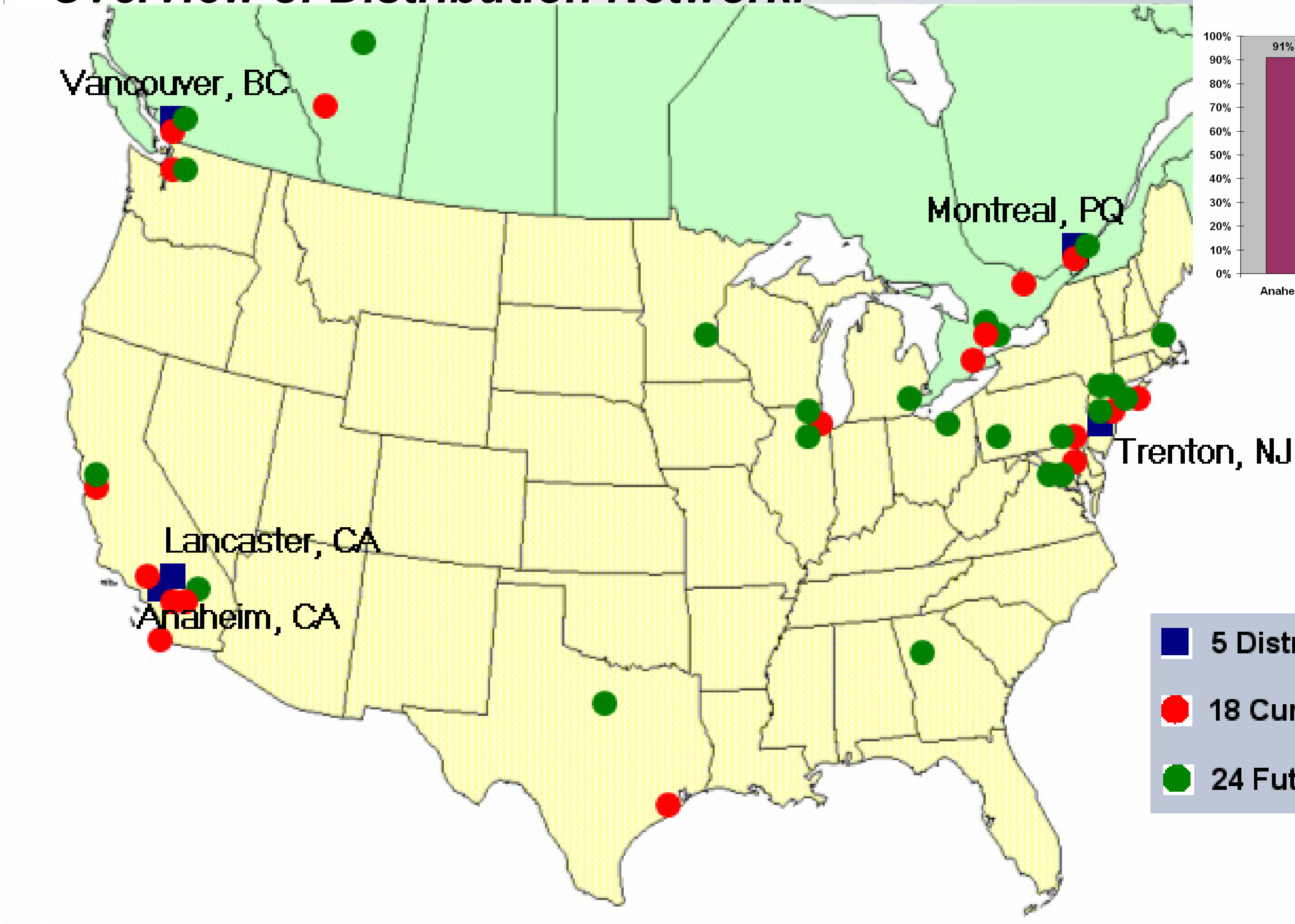
### *Overview*

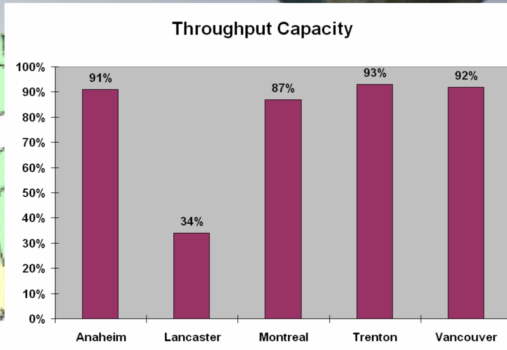
- IKEA is a home furnishings retailer
- North American sales of $1.7 billion
- Project sponsored by Distribution Services Group
- 5-year strategic distribution plan to support business goals:
  - Triple North American revenues
  - Triple quantity (m3) of goods sold
  - More than double number of retail stores, including entry into new markets
  - Reduce operating costs 1.5% per year
  - No more than 1.5 transit days from DC to retail store
  - Increase inventory turns to at least 5.5 per year

# Case Study: IKEA

CLM 2004 — Vision. Velocity. Value. — October 3-6, 2004, Philadelphia, PA

## *Overview of Distribution Network.*




- 5 Distribution Centers
- 18 Current Stores
- 24 Future Stores

# Case Study: IKEA



***Overview of Distribution Network.***

- 10,000+ SKUs
- 2500+ suppliers from 45 countries
- Expected shift in supply base to developing countries
- Supplier lead time up to 20 weeks
- 3 day lead time (1.5 days transit) from DC to store
- For fast-moving items, stores hold no more than 2-3 days of inventory
- Annual sales of $95 million for the average store
- Average inventory turns of 4.5 times per year
- All North American shipments via full truckload

# Case Study: IKEA



## *Project Objectives and Scope.*

### Network Analysis Questions

- Design the optimal distribution network to support company's 5-year growth and performance goals
- Examine multiple distribution strategies
  - 3 versus 2 service areas
  - segregate fast-moving and slow-moving items
  - tradeoffs: transport costs + facility costs vs. inventory holding costs
- Determine location, sizing and timing of new DCs or DC expansion
- Examine and quantify impact of alternative distribution strategies and network configurations, especially the trade-offs in costs, inventory and service levels to IKEA stores

### Business Goals

- Develop a planning process to analyze the distribution network that will be required to meet IKEA's business growth and store expansion plans
- Transfer model data and modeling knowledge to IKEA
- Maximize utilization of current assets and minimize capital investment required to meet expected growth
- Use model results as justification for capital budgeting approval for investment in distribution infrastructure

# Case Study: IKEA

CLM 2004
Vision. Velocity. Value.
October 3-6, 2004
Philadelphia, PA

## *Project Approach.*

| | | |
|---|---|---|
| **Project Organization** | ▪ Organize project team<br>▪ Finalize objectives, scope and schedule<br>▪ Discuss key business drivers and requirements | ▪ Determine how models should be structured<br>▪ Identify data requirements and data sources<br>▪ Assign responsibilities<br>▪ Develop project plan |
| **Data Definition and Collection** | ▪ Define product, store and/or supplier aggregations<br>▪ Define costs and cost structures<br>▪ Define key capacities in the supply chain | ▪ Gather, analyze and process store demand data<br>▪ Gather, analyze and process data describing historical supply chain activity |
| **Data and Model Validation** | ▪ Establish historical cost and volume metrics<br>▪ Measure model output against historical cost and volume metrics<br>▪ Identify variances | ▪ Address variances<br>▪ Rerun model<br>▪ Re-measure model output against historical cost and volume metrics |
| **Scenario Analysis and Interpretation** | ▪ Analyze alternative scenarios<br>▪ Measure each scenario against each other<br>▪ Evaluate feasibility and key risks of each scenario | ▪ Identify areas of greatest strategic opportunity<br>▪ Identify alternative scenarios and strategies based on results<br>▪ Optimize and analyze alternative scenarios |
| **Conclusions and Recommended Actions** | ▪ Confirm that recommended solution and strategies met business objectives<br>▪ Prepare final presentations and reports<br>▪ Present findings and recommendations | ▪ Recommend a solution that includes identification of highest priority opportunities<br>▪ Assist with implementation timelines and implementation process as needed |

# Case Study: IKEA

CLM 2004 Vision. Velocity. Value. October 3-6, 2004 Philadelphia, PA

## *Building the Model: Summary of Inputs.*

Freights Rates

DC Processes and Operating Capacities

Forecasted store demand over the next 5 years, including new stores

DC Capital Investment Costs And Expansion Options

Forecasted merchandise sourcing over the next 5 years

Inventory turns and cost data

DC Operating Costs

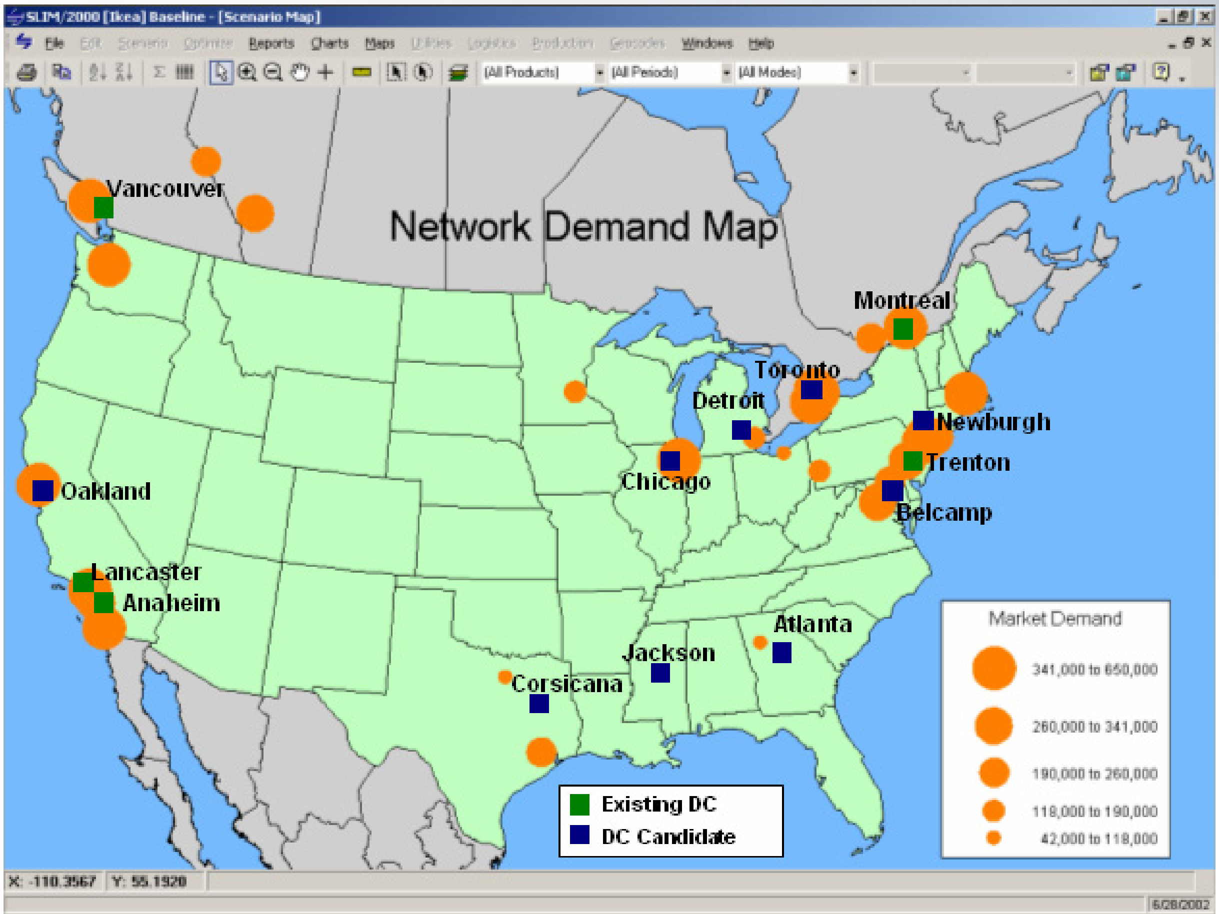
Candidate DC Locations

Policy and service constraints

# Case Study: IKEA

CLM 2004
Vision. Velocity. Value.
October 3-6, 2004
Philadelphia, PA

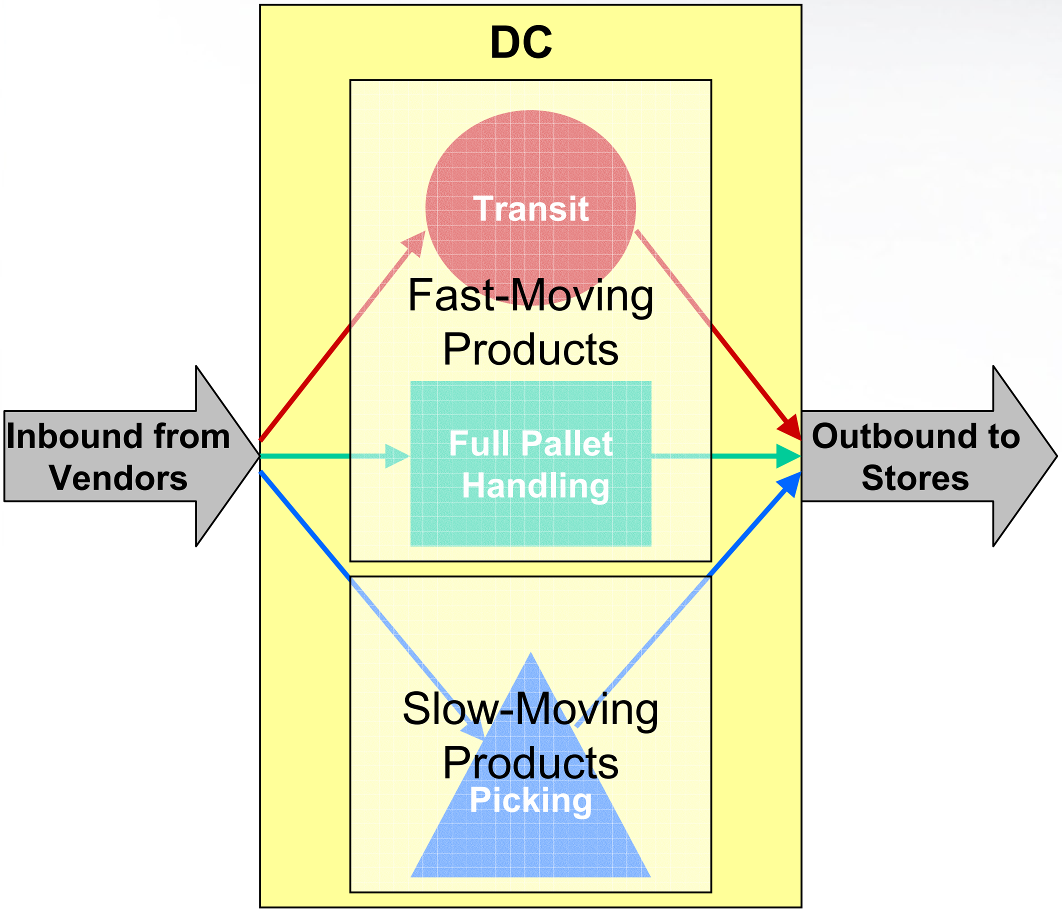
## *Building the Model: Candidate Locations.*



# Case Study: IKEA

CLM 2004
Vision. Velocity. Value.
October 3-6, 2004
Philadelphia, PA

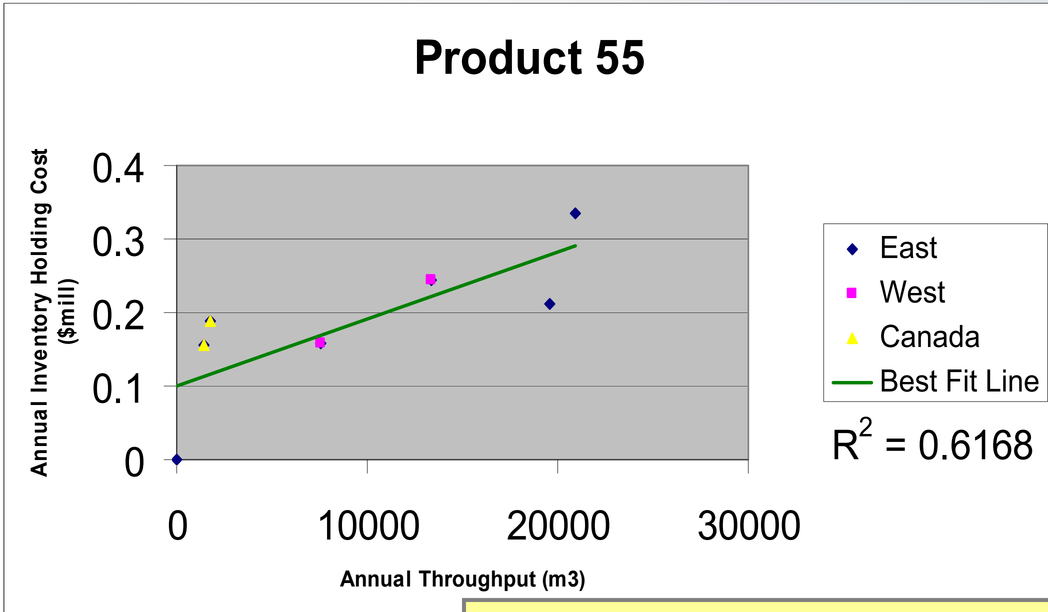
## *Building the Model: DC Handling Processes.*




- Product handling requirements:
  - **Transit items:** Receive > Stage > Ship
  - **Full Pallet Items:** Receive > Store > Retrieve > Ship
  - **Picked Items:** Receive > Store > Pick > Palletize > Ship
- SKUs segregated into fast- or slow-moving, then aggregated into product families
- Fast-moving and slow-moving through certain processes
- Fast-moving and slow-moving definitions based on annual velocity through DCs
- Costs and capacities on each handling process

# Case Study: IKEA

## *Building the Model: Inventory Holding Costs.*



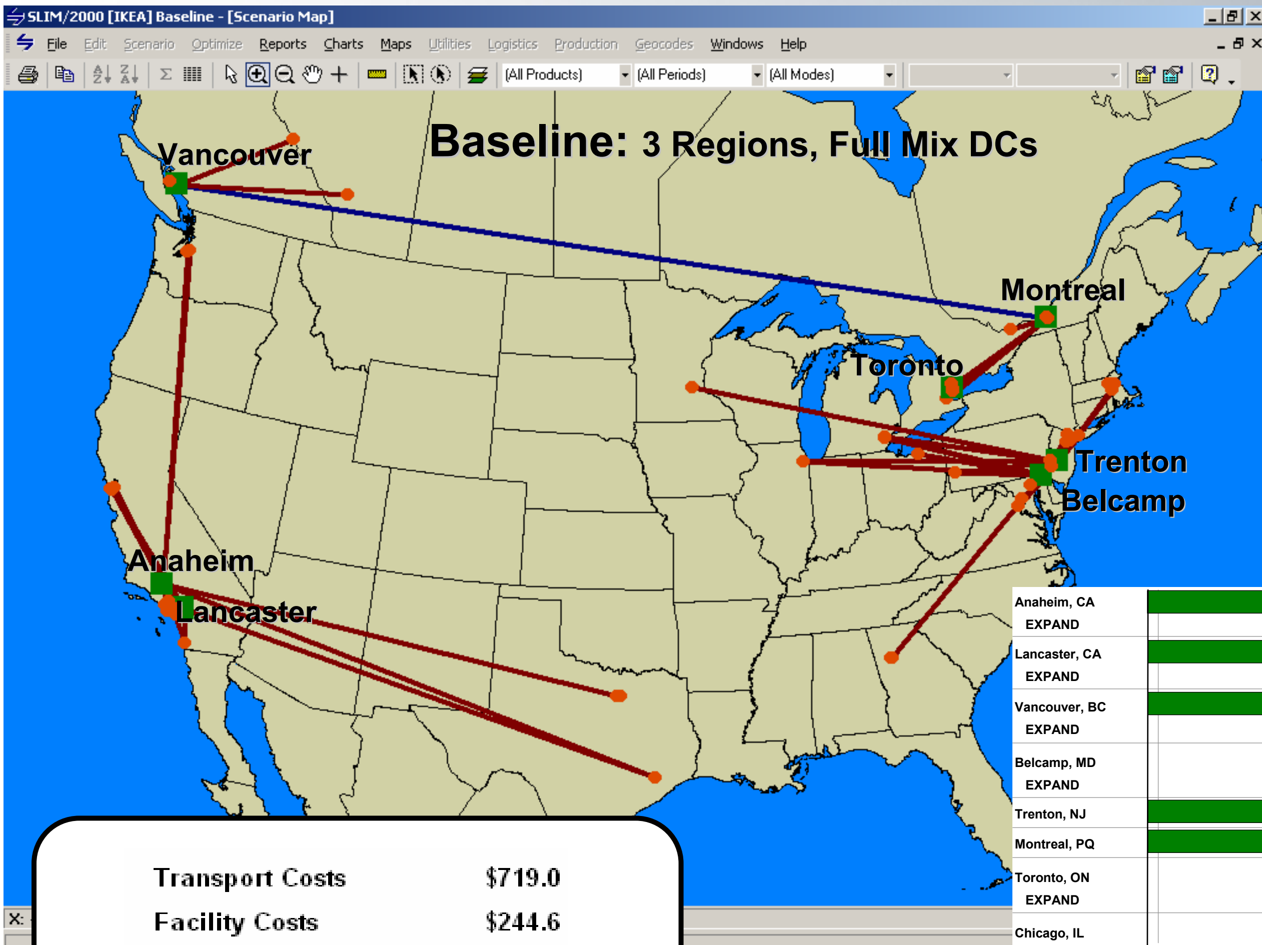

- Examined historical relationship between facility throughput and inventory holding costs
- Established a per unit holding cost, as well as a min. holding cost per single unit of throughput

**Example:**

Trenton DC
Product Family 55

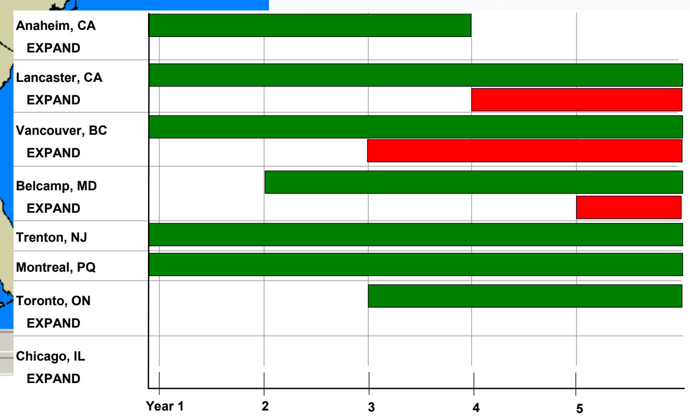
| | | Basecase Throughput | Inventory (landed cost $) | Inventory (units) | Inventory Turns |
|---|---|---|---|---|---|
| **Trenton DC** | Year1 | 21,163 | $861,330 | 4,810 | 4.4 |
| **Trenton DC** | Year2 | 22,036 | $881,826 | 4,924 | 4.5 |
| **Trenton DC** | Year3 | 25,225 | $956,778 | 5,343 | 4.7 |
| **Trenton DC** | Year4 | 27,555 | $1,011,520 | 5,649 | 4.9 |
| **Trenton DC** | Year5 | 29,740 | $1,062,843 | 5,935 | 5.0 |

# Case Study: IKEA




| | |
|---|---|
| Transport Costs | $719.0 |
| Facility Costs | $244.6 |
| Handling Costs | $172.3 |
| Inventory Costs | $240.7 |
| TOTAL COST | $1,376.6 |

## DC Location and Sizing



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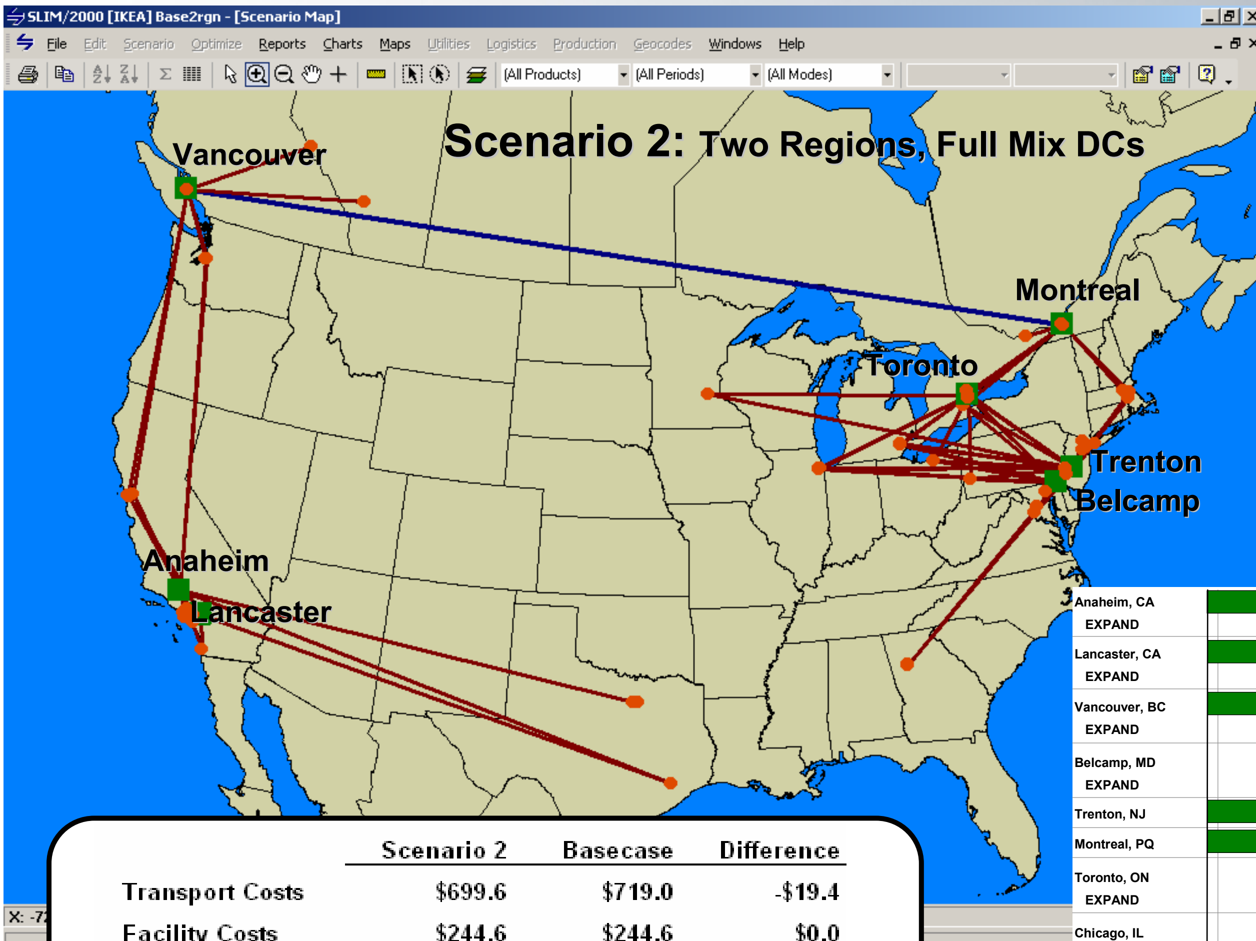
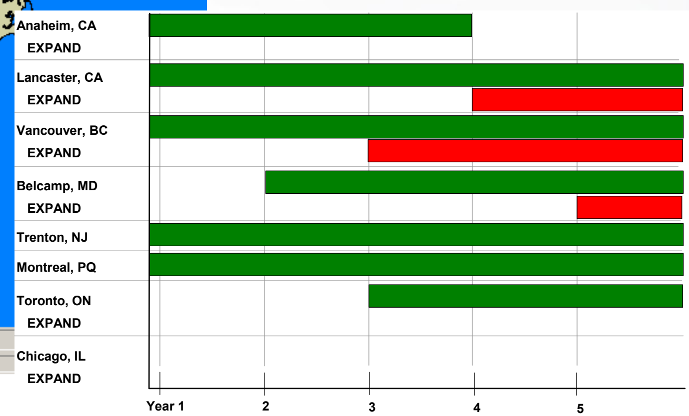



| | Scenario 2 | Basecase | Difference |
|---|---|---|---|
| Transport Costs | $699.6 | $719.0 | -$19.4 |
| Facility Costs | $244.6 | $244.6 | $0.0 |
| Handling Costs | $174.6 | $172.3 | $2.3 |
| Inventory Costs | $240.7 | $240.7 | $0.0 |
| TOTAL COST | $1,359.5 | $1,376.6 | -$17.1 |

## DC Location and Sizing



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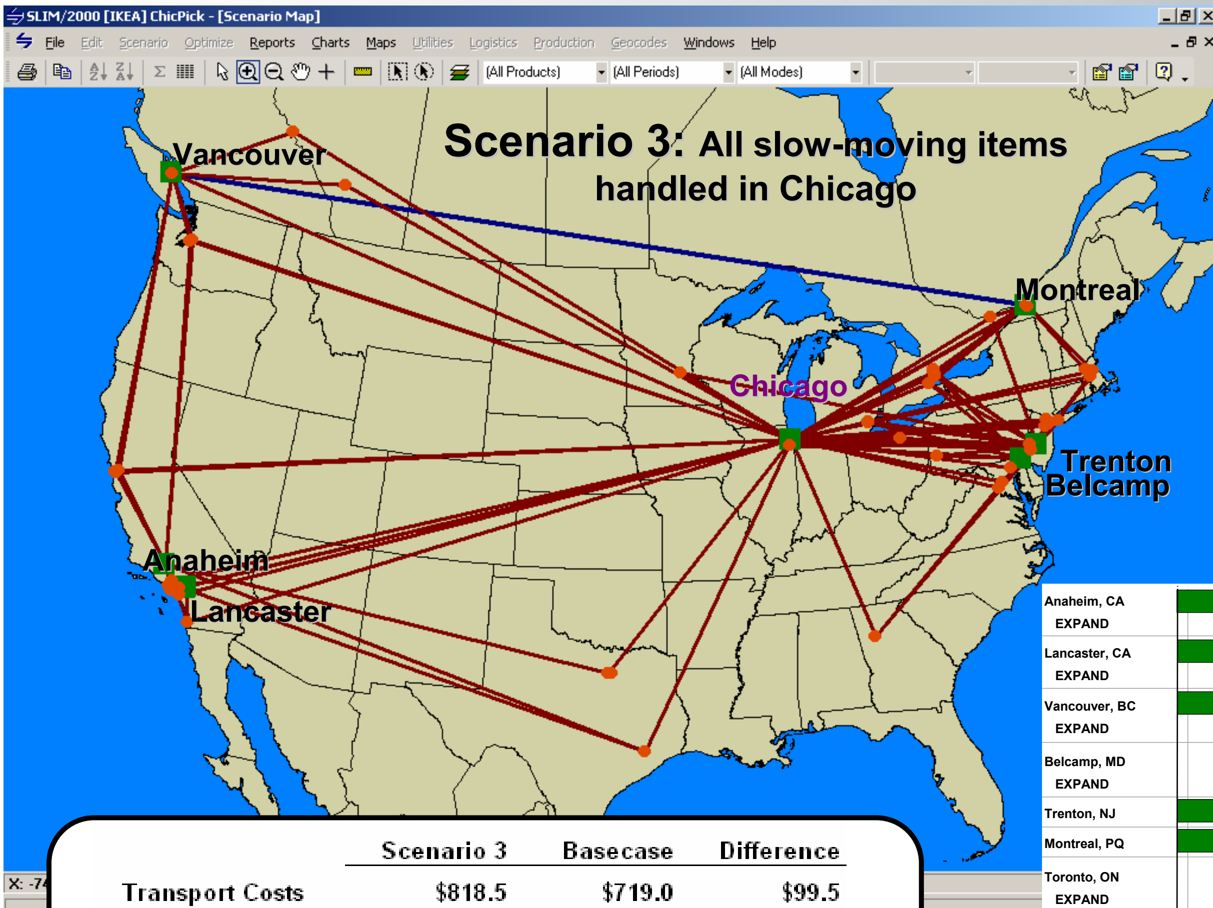
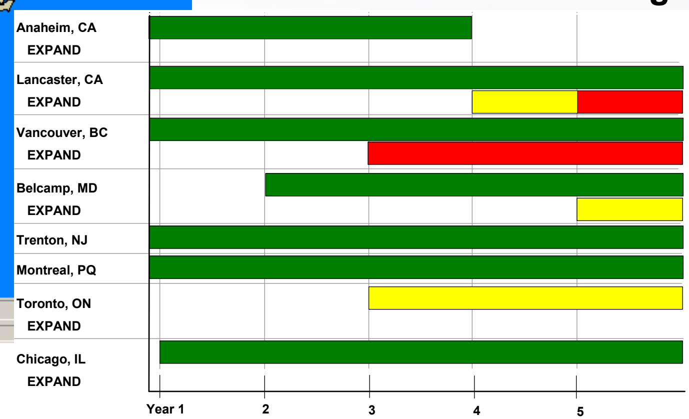



| | Scenario 3 | Basecase | Difference |
|---|---|---|---|
| Transport Costs | $818.5 | $719.0 | $99.5 |
| Facility Costs | $250.4 | $244.6 | $5.8 |
| Handling Costs | $170.9 | $172.3 | -$1.4 |
| Inventory Costs | $201.7 | $240.7 | -$39.0 |
| TOTAL COST | $1,441.5 | $1,376.6 | $64.9 |

## DC Location and Sizing



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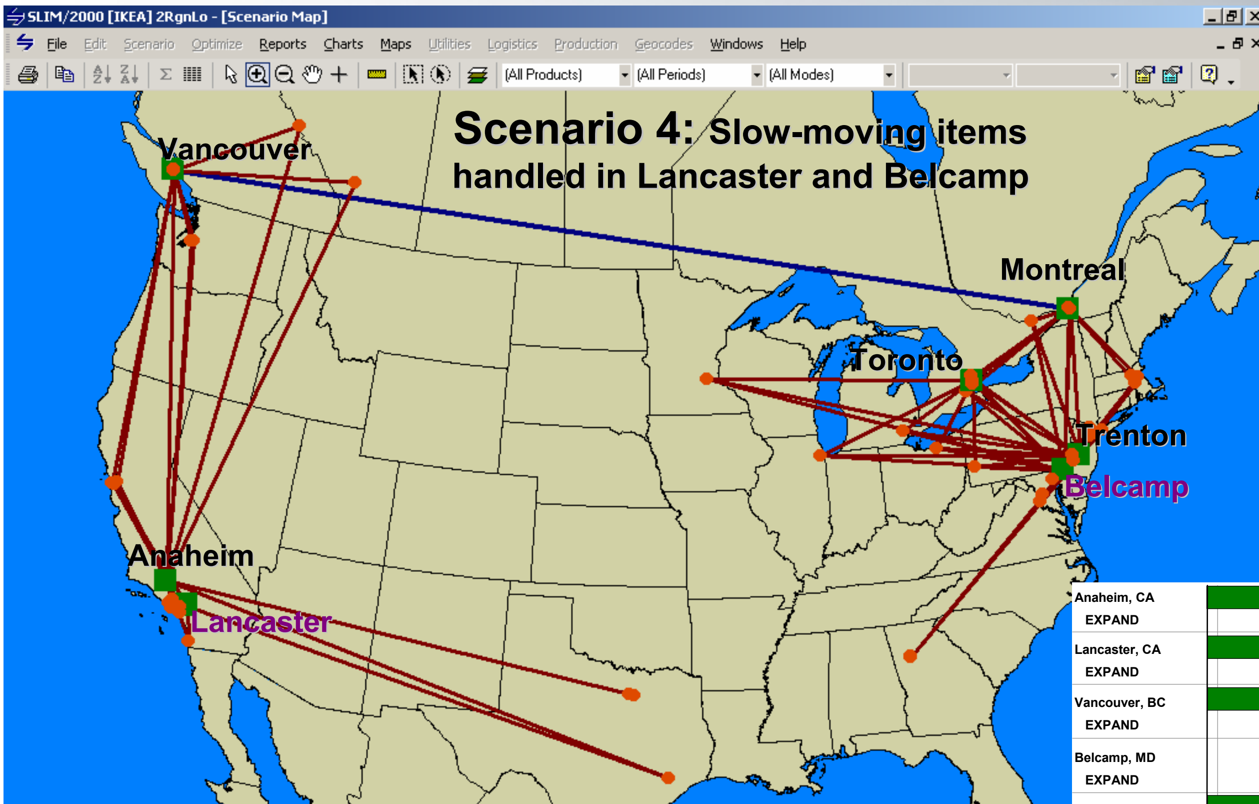
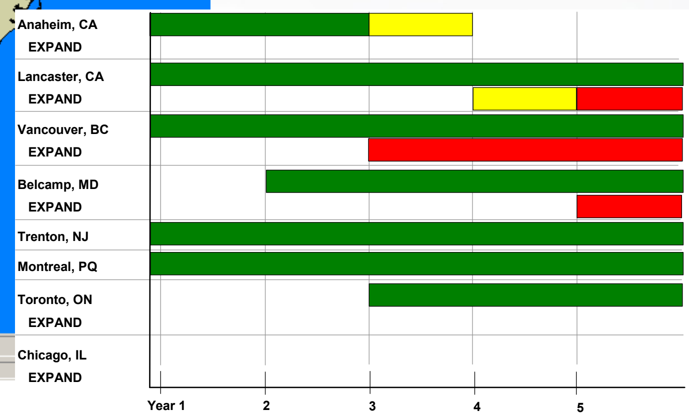



| | Scenario 4 | Basecase | Difference |
|---|---|---|---|
| Transport Costs | $725.4 | $719.0 | $6.4 |
| Facility Costs | $237.6 | $244.6 | -$7.0 |
| Handling Costs | $170.2 | $172.3 | -$2.1 |
| Inventory Costs | $208.2 | $240.7 | -$32.5 |
| TOTAL COST | $1,341.4 | $1,376.6 | -$35.2 |

## DC Location and Sizing



# Case Study: IKEA

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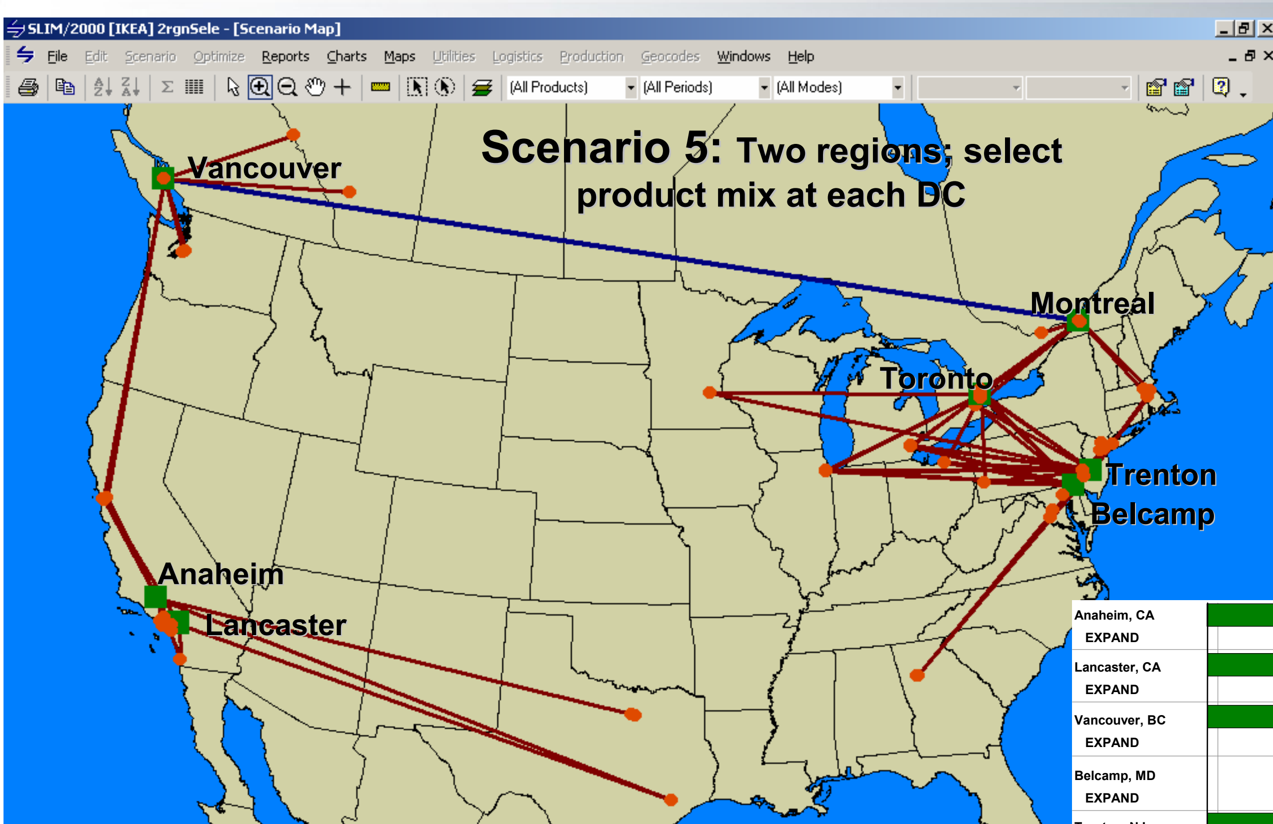
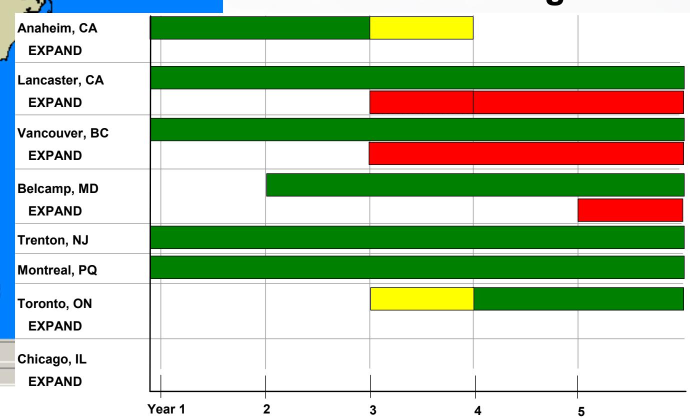



| | Scenario 5 | Basecase | Difference |
|---|---|---|---|
| Transport Costs | $706.1 | $719.0 | -$12.9 |
| Facility Costs | $236.2 | $244.6 | -$8.4 |
| Handling Costs | $171.1 | $172.3 | -$1.2 |
| Inventory Costs | $215.0 | $240.7 | -$25.7 |
| TOTAL COST | $1,328.4 | $1,376.6 | -$48.2 |

## DC Location and Sizing



# Case Study: IKEA

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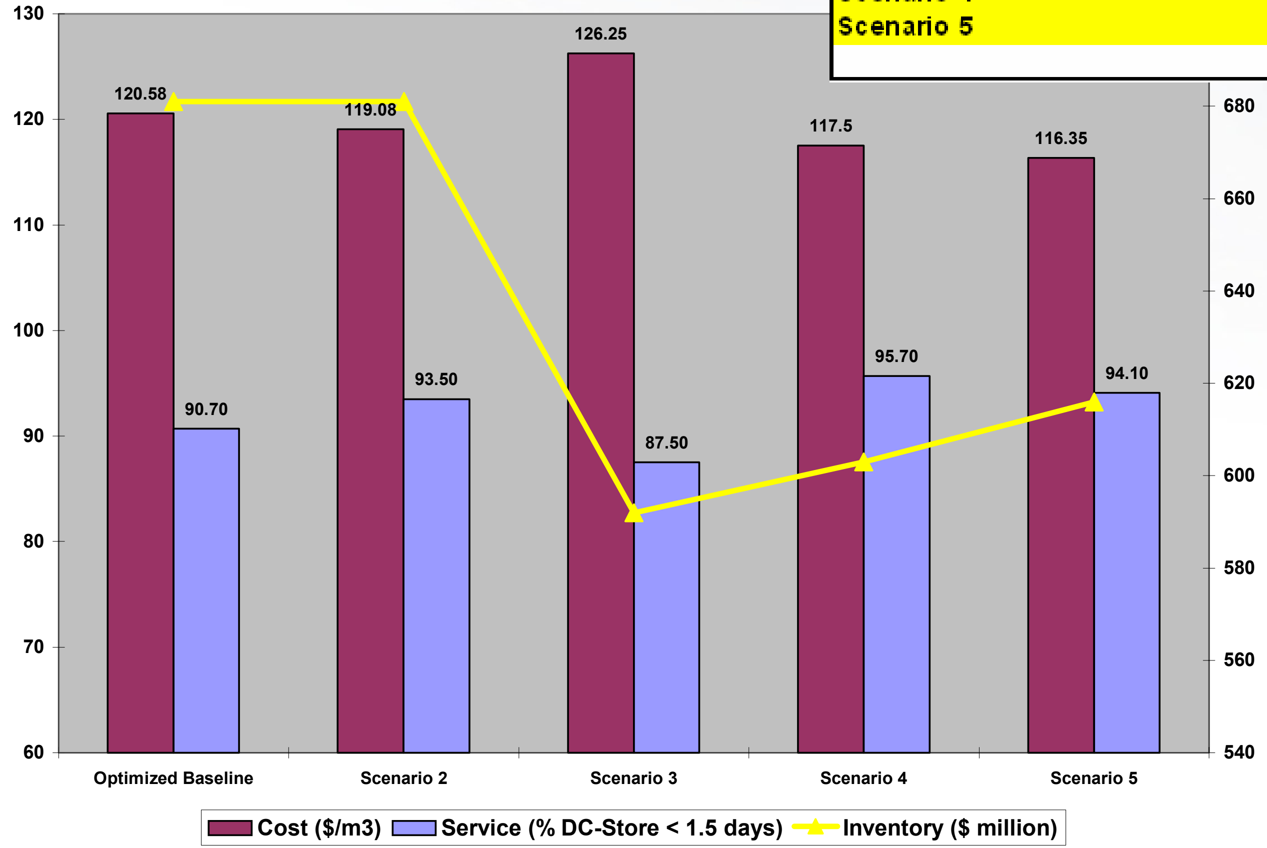
## *Strategy Comparisons.*

**SOLUTION RANKINGS** 1=best; 5=worst

| | Cost | Service | Inventory |
|---|---|---|---|
| Optimized Baseline | 4 | 4 | 5 |
| Scenario 2 | 3 | 3 | 5 |
| Scenario 3 | 5 | 5 | 1 |
| Scenario 4 | 2 | 1 | 2 |
| Scenario 5 | 1 | 2 | 3 |




### Scenario Descriptions

Optimized Baseline
Scenario 2: 2 regions; full mix DCs
Scenario 3: 1 facility for slow-moving items
Scenario 4: 1 East and 1 West DC for slow-moving items
Scenario 5: Select products at each DC

# Case Study: IKEA

CLM 2004 Vision. Velocity. Value. October 3-6, 2004 Philadelphia, PA

## *Capital Expenditures.*

CAPITAL EXPENDITURES ($ million)

| | New Facilities | Expand Facilities | Total | Rank |
|---|---|---|---|---|
| Optimized Baseline | 69.3 | 21.0 | 90.3 | 3 |
| Scenario 2 | 69.3 | 21.0 | 90.3 | 3 |
| Scenario 3 | 89.1 | 7.0 | 96.1 | 5 |
| Scenario 4 | 69.3 | 14.0 | 83.3 | 2 |
| Scenario 5 | 59.4 | 22.5 | 81.9 | 1 |

### Scenario Descriptions

Optimized Baseline
Scenario 2: 2 regions; full mix DCs
Scenario 3: 1 facility for slow-moving items
Scenario 4: 1 East DC and 1 West DC for slow-moving items
Scenario 5: Select products at each DC

- Scenarios 4 and 5 extend useful life of DCs by delaying expansion investments in existing DCs and/or investments in new DCs

# Case Study: IKEA

CLM 2004
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October 3-6, 2004
Philadelphia, PA

## *Other Considerations.*

### Product Mix Results (% carried by DC)

| | Current | Baseline | Scenario 2 | Scenario 3 | Scenario 4 | Scenario 5 |
|---|---|---|---|---|---|---|
| Anaheim CA | 100% | 100% | 100% | 50% | 50% | 30% |
| Lancaster CA | 100% | 100% | 100% | 50% | 100% | 98% |
| Vancouver BC | 100% | 100% | 100% | 50% | 50% | 100% |
| Belcamp MD | NA | 100% | 100% | 50% | 100% | 73% |
| Trenton NJ | 100% | 100% | 100% | 50% | 50% | 91% |
| Montreal PQ | 100% | 100% | 100% | 50% | 50% | 96% |
| Toronto ON | NA | 100% | 100% | NA | 50% | 64% |
| Chicago IL | NA | NA | NA | 97% | NA | NA |

- ❑ Strategy of carrying a select product mix at each DC (Scenario 5) is very difficult to implement, manage and maintain.
- ❑ So many combinations of source DC-store-product creates operational complexity.
- ❑ Can create transport inefficiencies on inbound.

### Additional Advantages of Scenario 4 (1 East DC & 1 West DC for slow-moving items)

- ❑ Better Service
  - Reduces lead time to the Stores for priority products
  - Supports a higher Goods Availability
- ❑ Accommodates Growth/Expansion More Easily
  - More flexible network for the future to accommodate the retail growth
  - Allows quicker expansion into new markets with a smaller, high volume DC
- ❑ Operational Impact on DCs
  - Greater product flow efficiencies in DCs when fast-moving segregated from slow-moving

# Case Study: IKEA

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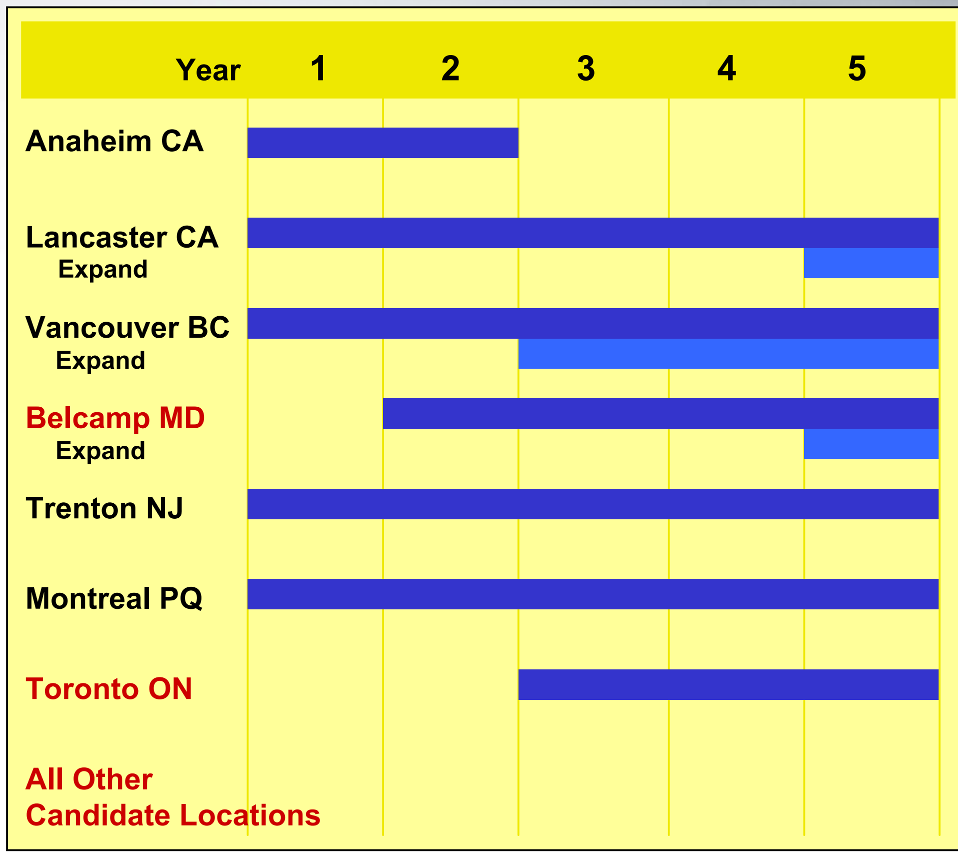
## *Conclusions.*

- Network should be treated as 2 service regions
- Dedicated DC in East and West to handle slow-moving items is the preferred product mix strategy; i.e. Scenario 4 preferred to Scenario 5
    - Operationally feasible to implement, manage and maintain
    - Better inbound transport efficiencies when supply regions disaggregated
    - Greater **flexibility** in supporting growth
    - Better **service** by focusing on priority products
    - Among **low-cost** solutions

**Optimal DC Network to Support Growth**




■ = DC that did not exist at time of project

# Case Study: IKEA

CLM 2004
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***Company Actions.***

- Acquired property in Belcamp, MD, including enough land for future expansion
- Belcamp DC has begun operating
- Service areas re-aligned, Canadian and US networks integrated
- Re-evaluating plans for Anaheim, CA
- Have implemented distribution strategy for fast-moving and slow-moving items, and have seen 10% reduction in affected buffer stocks as a result
- Continuously using software to evaluate expansion of distribution network

# Case Study: IKEA



## *Lessons Learned*

- Well-designed pilot project allowed in-house Enterprise Resource Optimization (ERO) Team to absorb supply chain modeling technology in a few weeks
- Strategic supply chain planning can and should be a continuous, on-going activity
- Scenario results must be closely examined with respect to favorable or unfavorable qualitative factors
- Inventory costs and customer service considerations can be integrated into holistic supply chain optimization

# Worldwide Sourcing in BEACON Industrial Chemicals

- Company Background
- Modeling Requirements
- Results

# Company Background

- Worldwide Operations: feedstock sourcing, manufacturing, packaging, distribution
- Approximately 20 plant sites in North America, South America, Europe and Asia
- 200 products in about 7 product lines sold to 2000+ customers worldwide

- **Major markets are zeolites, plastics, paper, polishing, ceramics, adsorbents and catalysts, refractories, coatings, abrasives, aluminum smelting, and water treatment**
- **Beacon has an inverted “Y” supply chain with few feedstocks and an explosion of products occurring within the manufacturing operations**
- **Annual sales over $500 Million**

# Beacon Supply Chain

Total Supply Chain Costs:

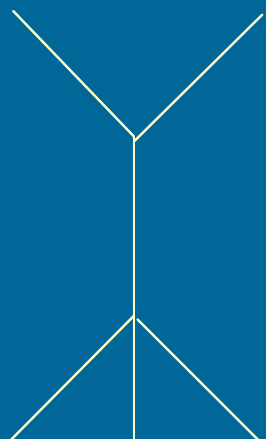
| | |
|---|---|
| Feedstock Costs | ~ 25% |
| Logistics Costs | ~ 20% |
| Manufacturing Costs | ~ 55% |

Opportunities exits to reduce manufacturing and logistics costs via supply chain optimization and management

# Manufacturing Process Flows

## Cements Process

1 Feedstock Additives



6 Cement
Products out

## Tabular Process

1 Feedstock

30 Coarse
Products out

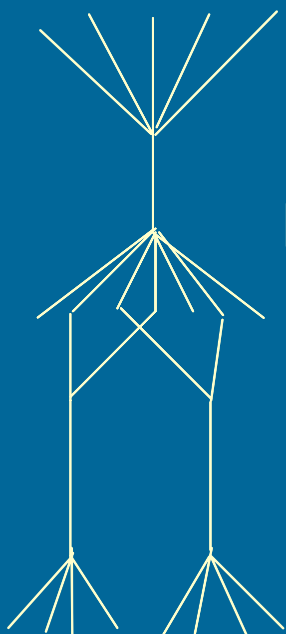
10 Fine
Products out

*Packaging and SQRs create further differentiation*

# Manufacturing Process Flows

## Calcines Process

4 Feedstocks Additives

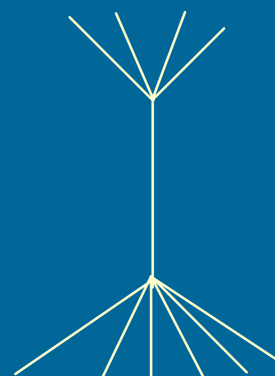


15 Kiln Products

35 Continuous & Batch Products out

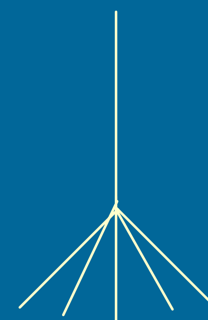
## Hydrate Chemicals Process

2 Feedstocks



15 Hydrate Products out

1 Feedstock



15 Hydral Products out

# Supply Chain Planning Initiatives

The Division conducted a strategic analysis of the business in the 1990’s. Analysis highlighted impact of  on cost of goods sold and need to better manage manufacturing assets, growth and profitability.

These are driven by:

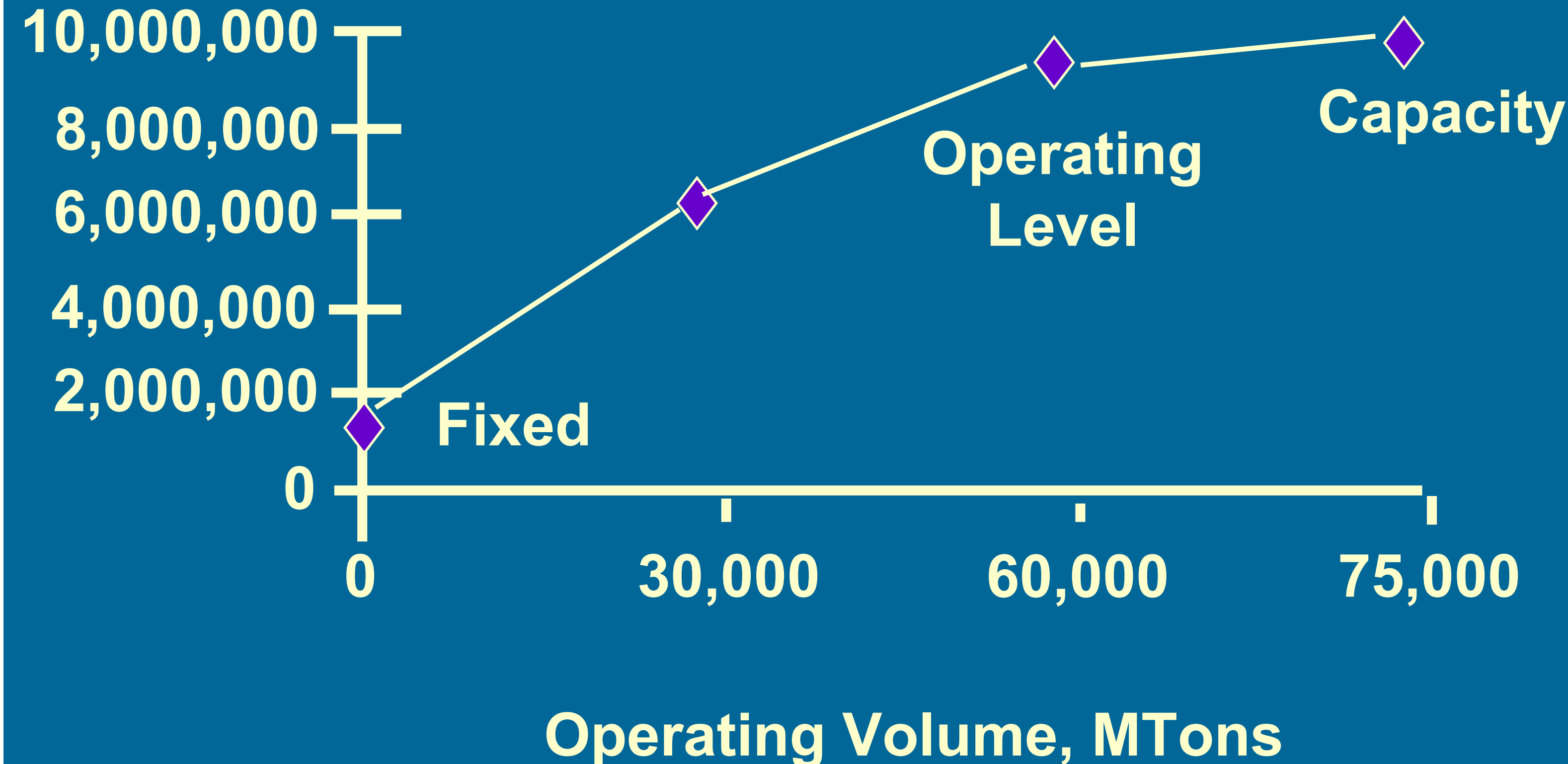
- integrating and leveraging worldwide information, commercial and sourcing positions
- pursuing strategic alliances
- aggressively introducing new products, applications and services
- developing and transferring technology

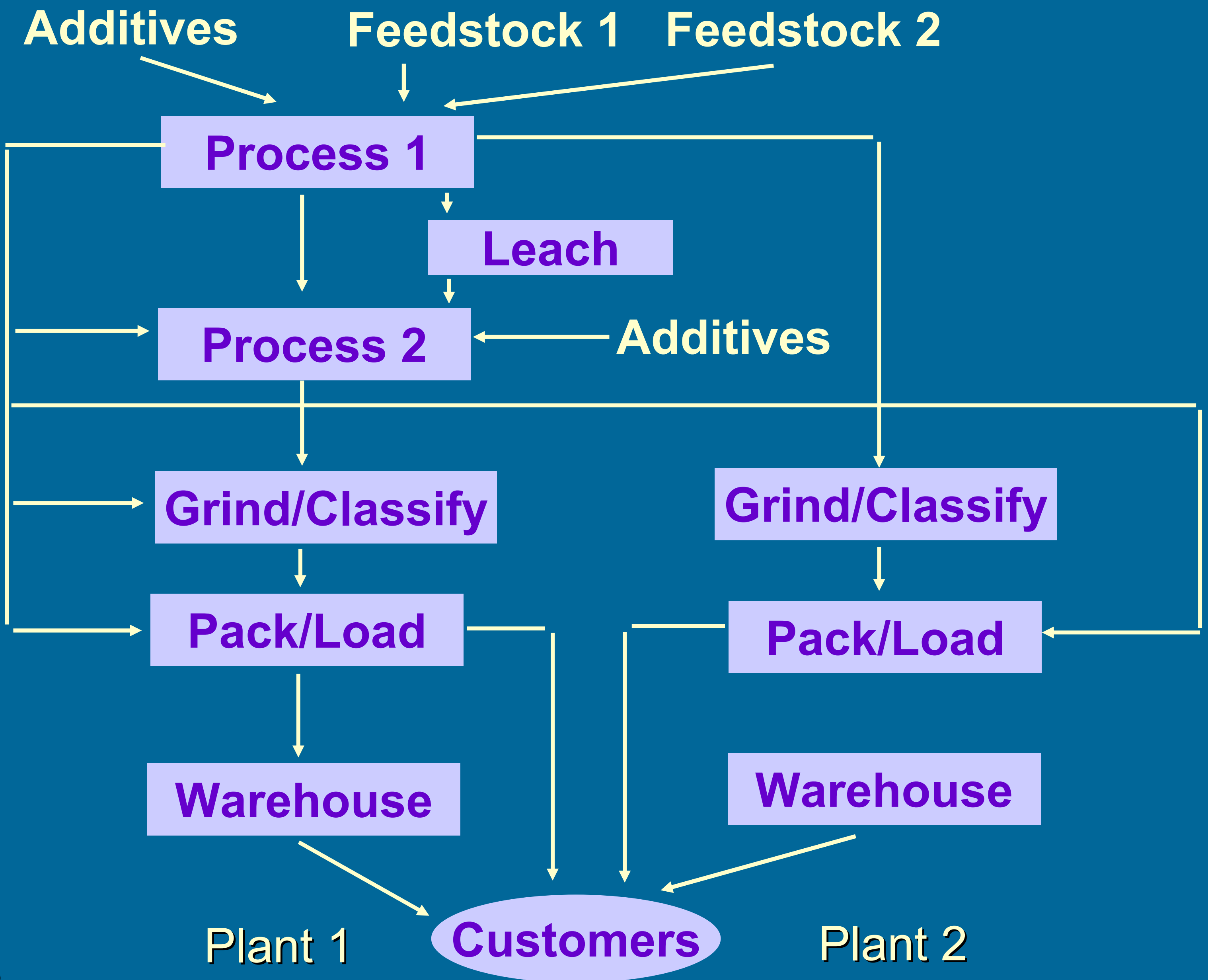
# Supply Chain Modeling Requirements

- Capture multiple stages of manufacturing for individual product lines
- Allow fixed costs and economies of scale for manufacturing facilities and processes within facilities (these costs had to be standardized across plants)

- Allow intermediate products to be shipped among plants
- Allow 2000+ customer ship-to locations
- Allow flexible accounting of multiple currencies
- Optimize on total cost or total margin

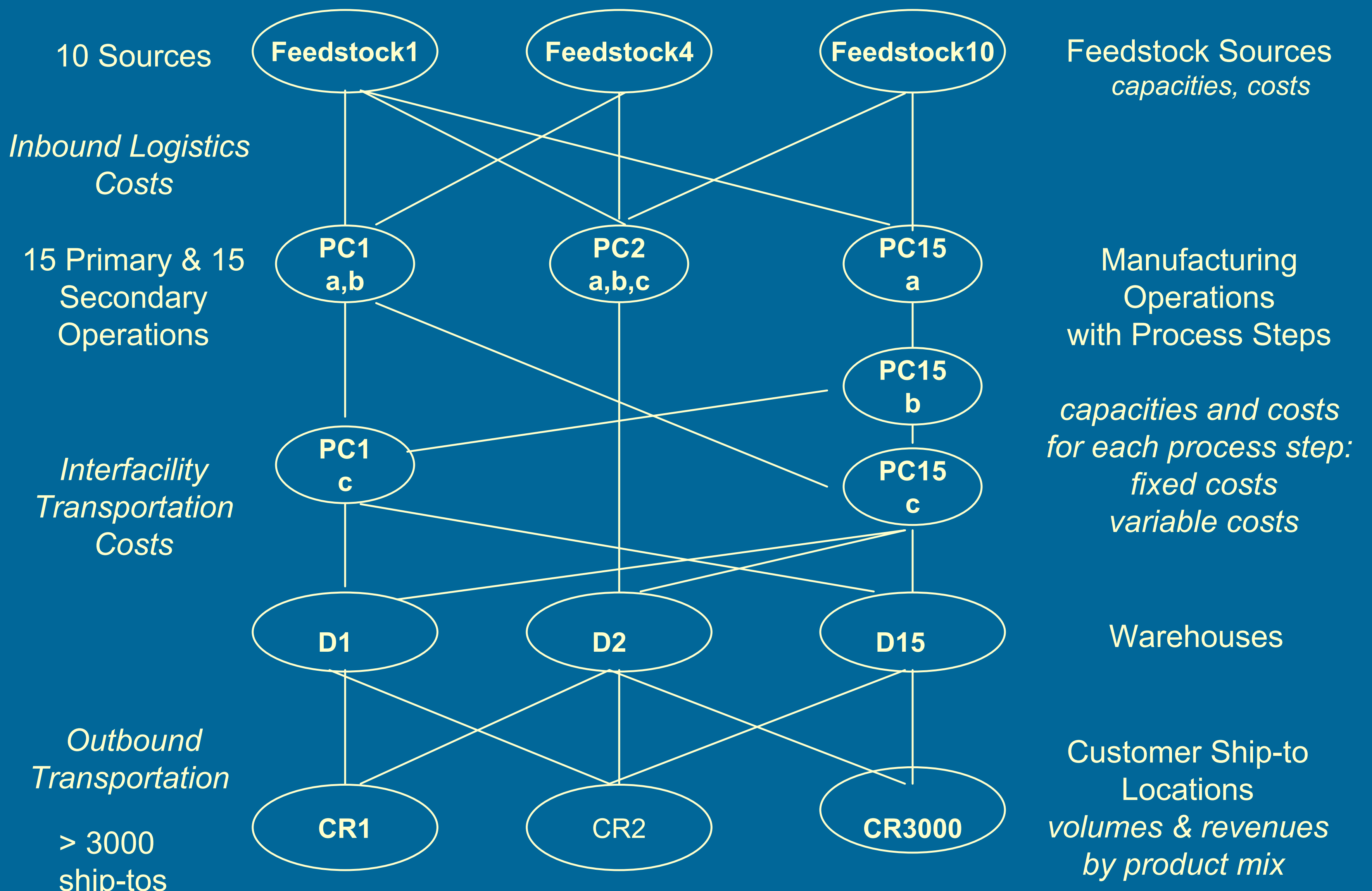
# Example of Cost vs Operating Volume Curve





Additives
Feedstock 1
Feedstock 2
Process 1
Leach
Process 2
Additives
Grind/Classify
Grind/Classify
Pack/Load
Pack/Load
Warehouse
Warehouse
Customers
Plant 1
Plant 2

# Model Requirements for Supply Chain Applications




Data can be input in different currencies & units of measure

# Analysis Using an Optimization Model

Scenario 1 - Basecase: Constrained to current supply chain flow

Scenario 2 - No constraints for supply

Scenario 3 - Projected market growth analysis

| | Scenario 1 | Scenario 2 | Scenario 3 |
|---|---|---|---|
| Total Margin: | $20,774,419 | $29,947,381 | $51,312,905 |
| Total Revenue: | $133,573,669 | $133,573,669 | $175,467,305 |
| Total Costs: | $112,799,250 | $103,626,288 | $124,154,400 |
| | | | |
| Feedstock Costs | $34,428,988 | $33,358,175 | $43,639,425 |
| Inbound Trans Costs | $7,551,950 | $7,134,050 | $9,409,050 |
| Interfacility Trans Costs | $657,470 | $3,952,475 | $5,760,330 |
| Mfg. Costs | $61,375,848 | $49,022,938 | $51,566,913 |
| Outbound Trans Costs | $8,784,995 | $10,158,649 | $13,778,688 |
| | | | |
| Volume, MTons | 159,420 | 159,420 | 209,420 |

# Results

- Applied to a range of strategic planning problems
  - annual production planning
  - investment planning for capacity expansion, acquisitions, joint ventures, expansion of logistics network
  - evaluation of new products and new processes
- Significant cost savings and increases in margins identified for these problems

# Lessons Learned

- Well-designed pilot project allowed in-house Enterprise Resource Optimization (ERO) Team to absorb supply chain modeling technology in a few weeks
- Strategic supply chain planning can and should be a continuous, on-going activity
- Extending supply chain cost minimization to net revenue maximization is technically possible in a commodities company, but organizationally difficult
- Company politics can create barriers to improving supply chain performance through holistic planning

Post merger consolidation of two pet food companies

**Acme Pet Care** — **Acquires** — **Tasty Pet Chow**

30-year old, $600-million, private label pet food supplier, with a focus on large, national accounts

3-year-old, $300-million, private label pet food supplier with regional brands -- grown through a series of acquisitions

Focused sites economically servicing national accounts

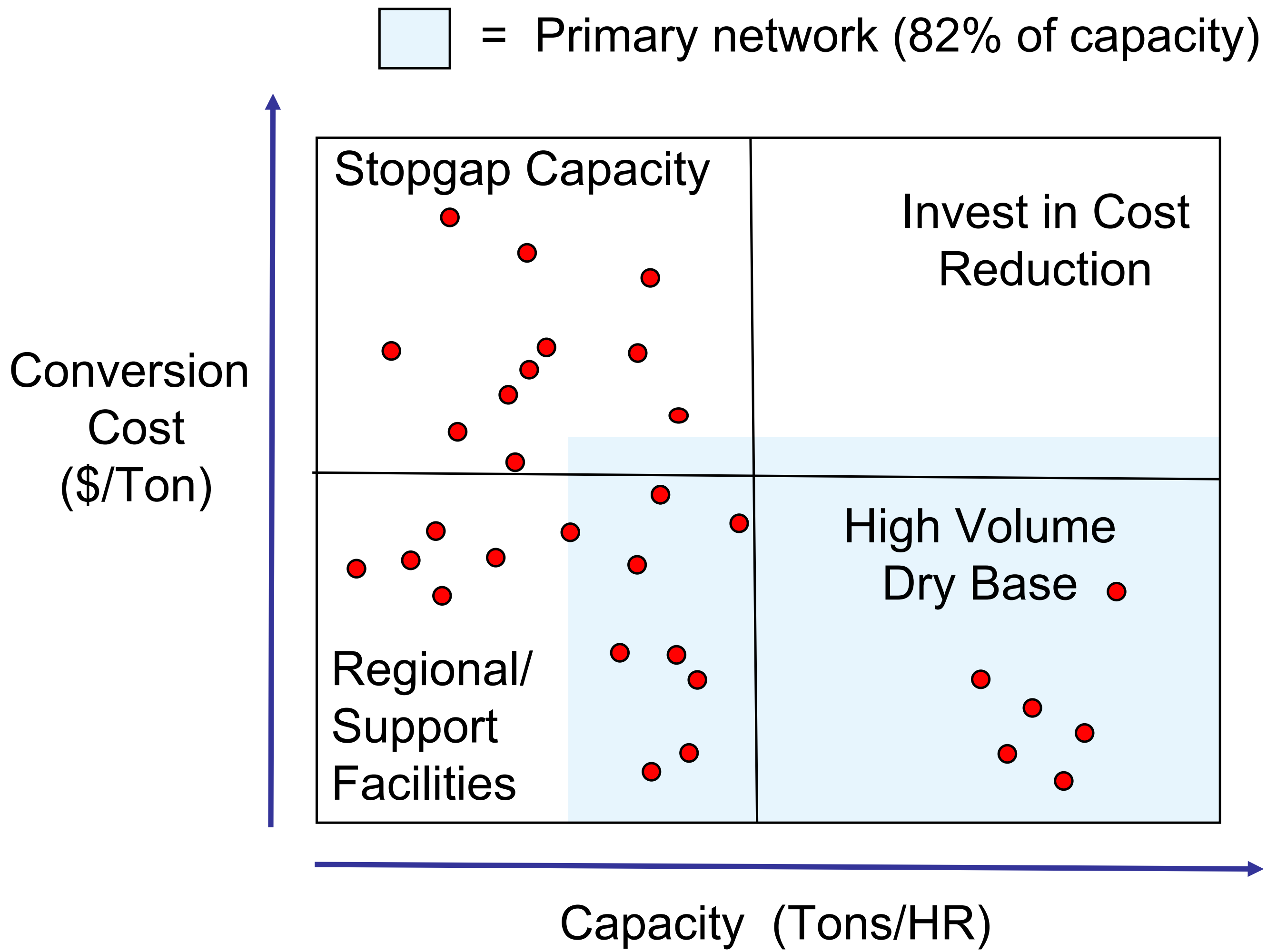
+

Rapid make-to-order service at low cost

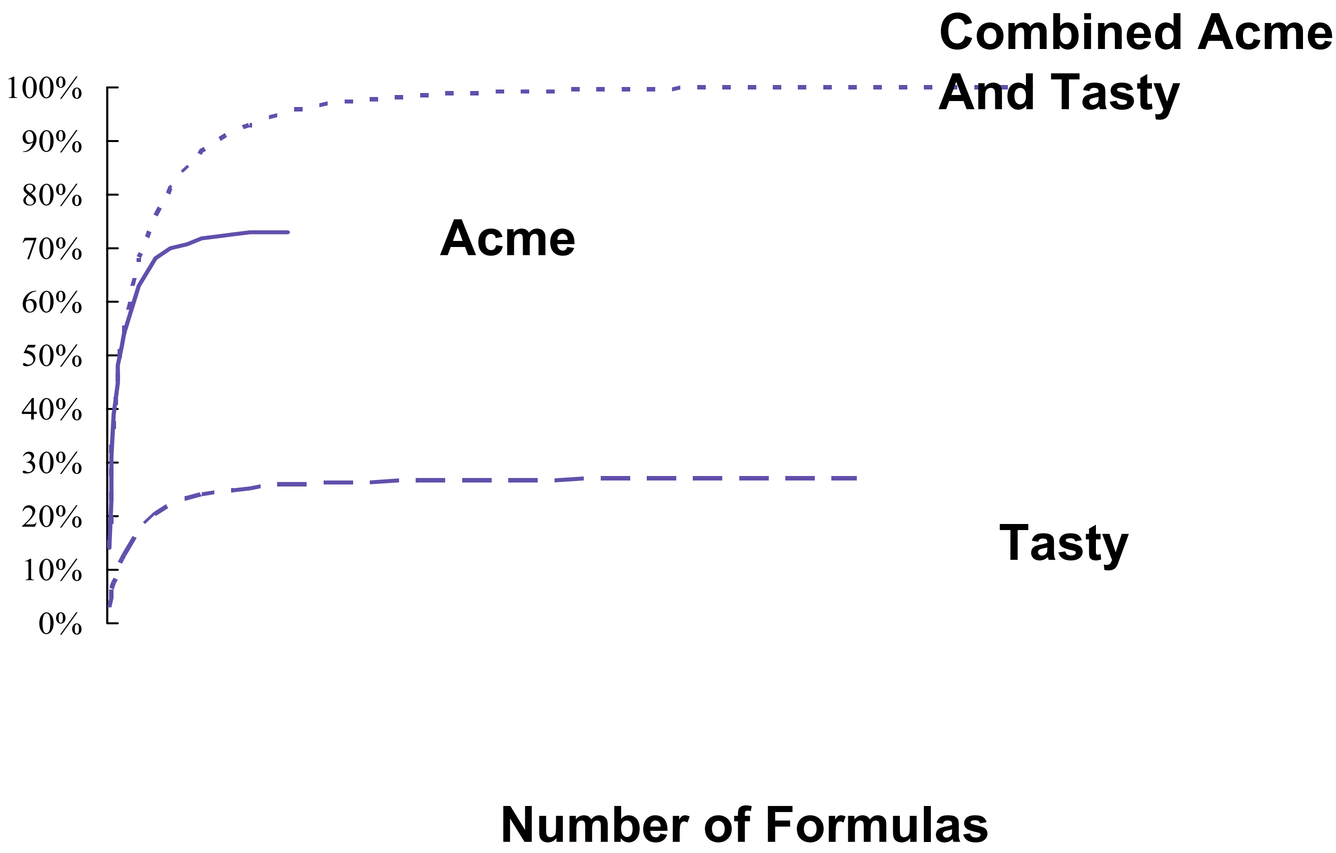
# Strategic Differences

| Acme Pet Care | Tasty Pet Chow |
|---|---|
| Strong central control | Productivity targets based on metrics |
| Facilities run 6 days/week | Facilities run 5 days/week |
| Designed for long runs | Designed for short runs |
| 2 – 4 Extruders per plant | Single extruder plants |

# Network-wide Cost/Capacity Differences



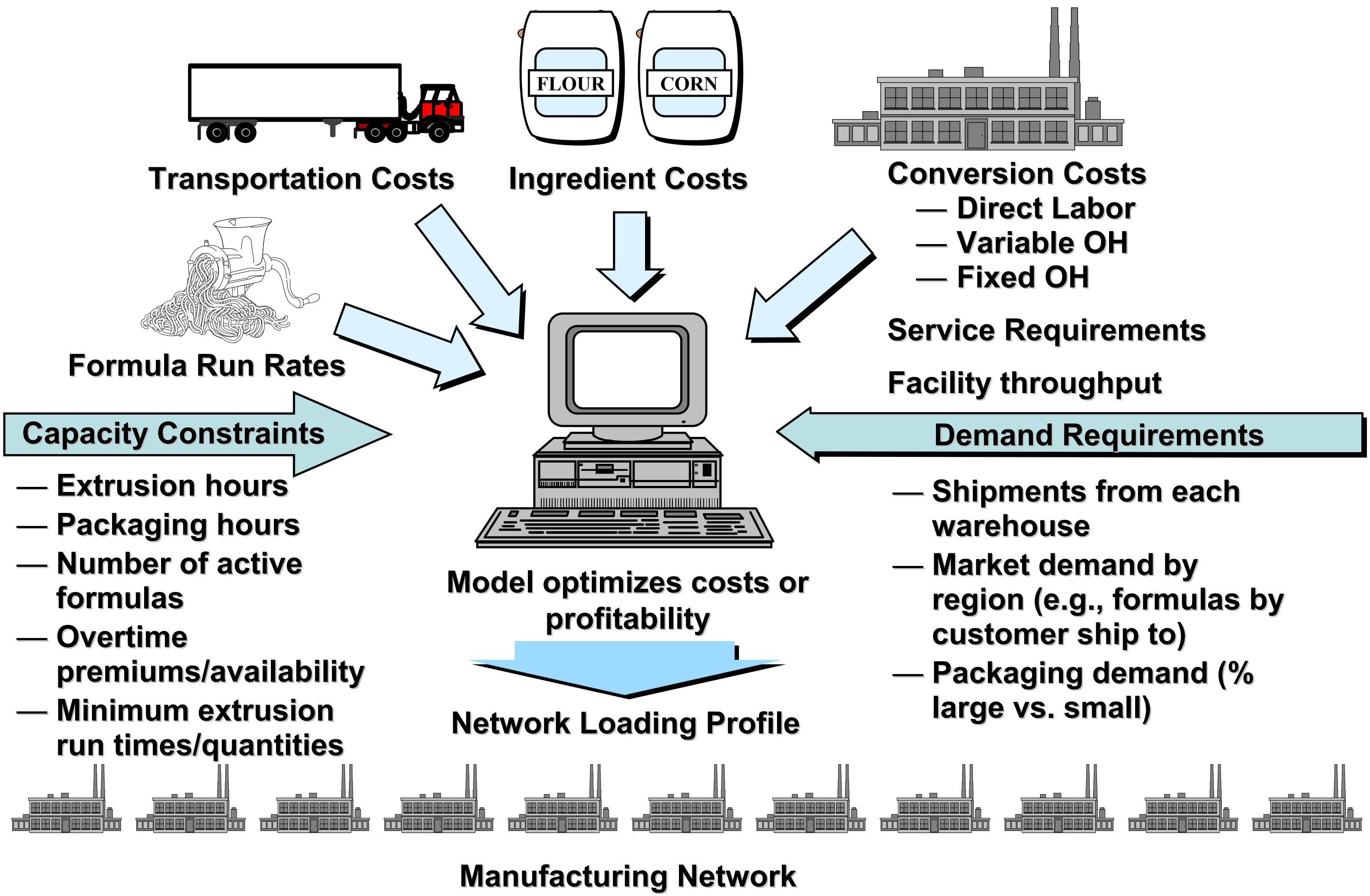
# Formula Complexity Significant Driver of Cost Differences



# Consolidation Study Questions

- What constraints and incompatibilities (for the near – and long-term) exist? For example, which formulas may be run at each plant and which sizes may be packaged there?
- What cost reduction and capacity enhancement opportunities result from leveraging network consolidation?
- What is an optimal utilization of the collective capacities and capabilities of the combined network?
- What capacity does the consolidated network have to meet increases in product demand?

# Data and Model Generation



# Consolidation Study Results

- Number of plants reduced from 31 to 24; some equipment relocated
- 4% of annual production moved to more efficient facilities
- 9% reduction in total supply chain costs
- Extension to tactical planning
  - System used on a quarterly basis to allocate projected demand to plants based on relative plant efficiencies, commodity inventories, and other factors
  - System used to analyze initiatives for accepting and satisfying customer order; yearly contribution to net revenue in the millions of dollars

# Lessons Learned

- Supply chain consolidation is necessary and desirable following mergers or acquisitions
- Data-driven models must be used to help senior management unravel the complex interactions and ripple effects that make consolidation difficult and important – payback often in the tens of millions of dollars
- New business processes should be put in place after consolidation  to apply data-driven supply chain management to tactical planning