SUPPLY CHAIN MISSION STATEMENT

- To create a competitive advantage for Welch's through purchasing, manufacturing and distributing products and services which provide superior value to our customers.

SOME IMPORTANT DEFINITIONS

- Supply Chain Dynamics
  - The flow of materials from vendors to manufacturing plants, and finally to the customer

Dynamic Analysis → Multiple Time Periods

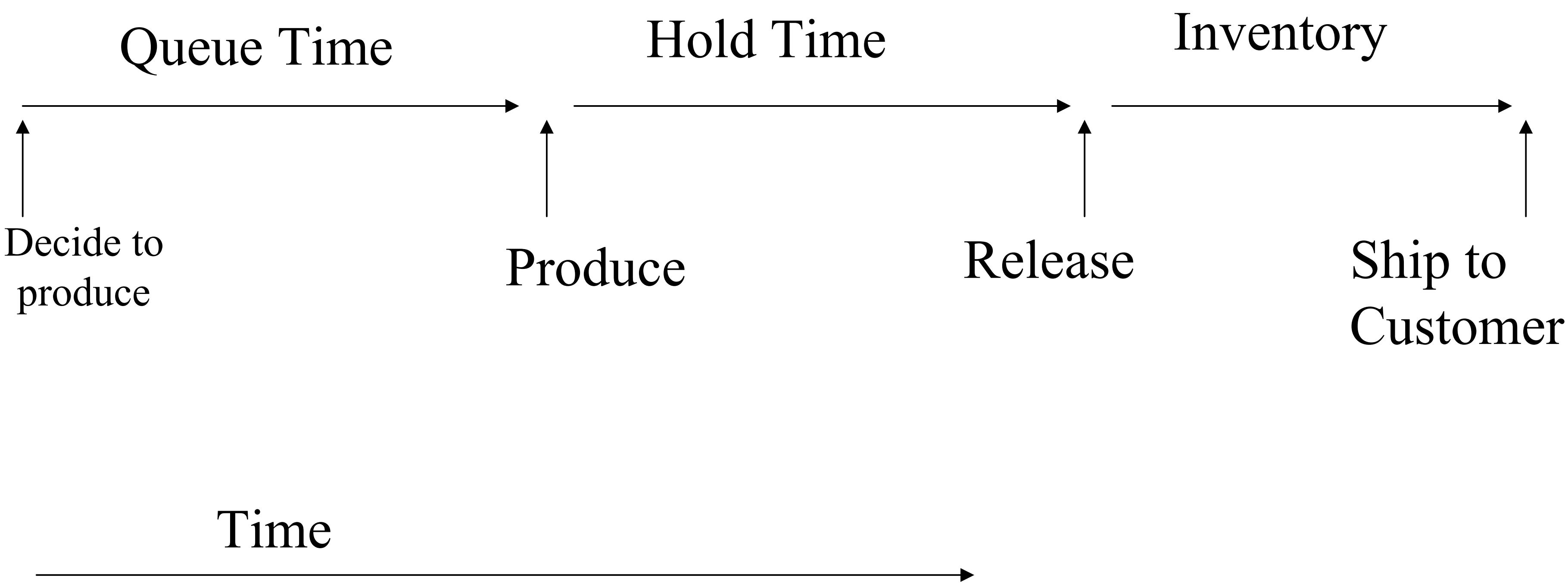
- Network Planning
  - The strategic location and size of manufacturing plants in relation to raw material sources and customers

Static Analysis → Single Time Periods

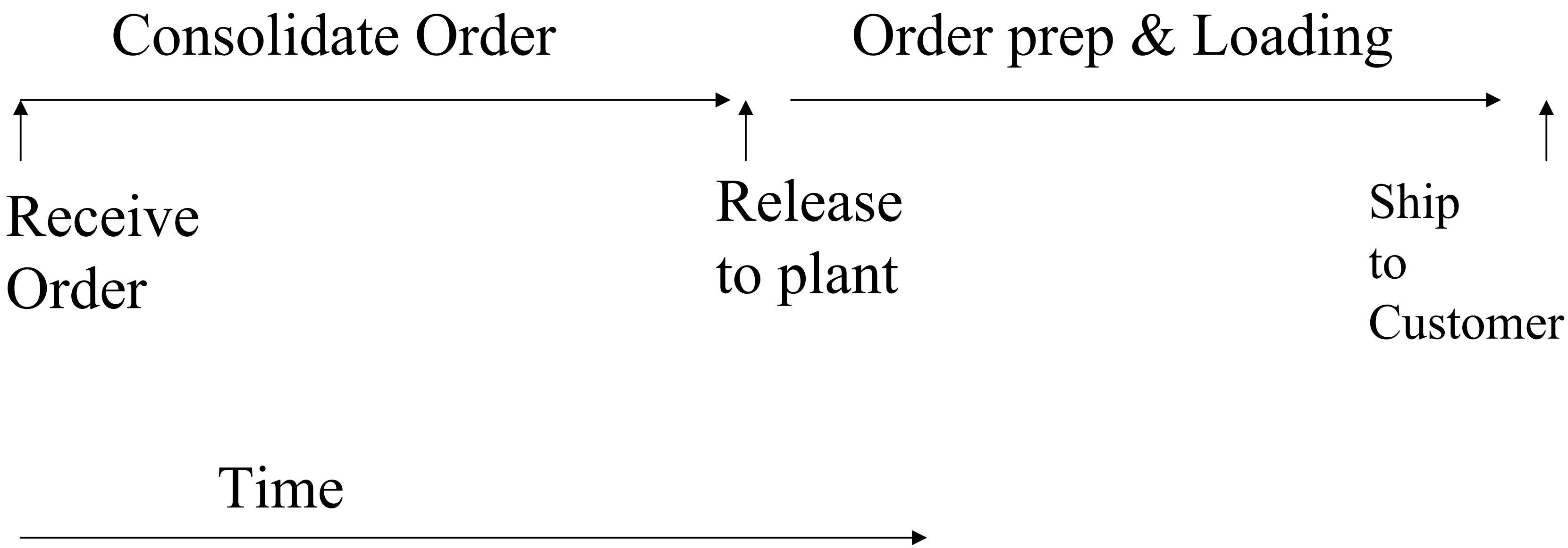
Supply Chain Dynamics

- Production planning and scheduling
- Lot sizing
- MRP
- Continuous Replenishment Systems
- "Fits and Starts"

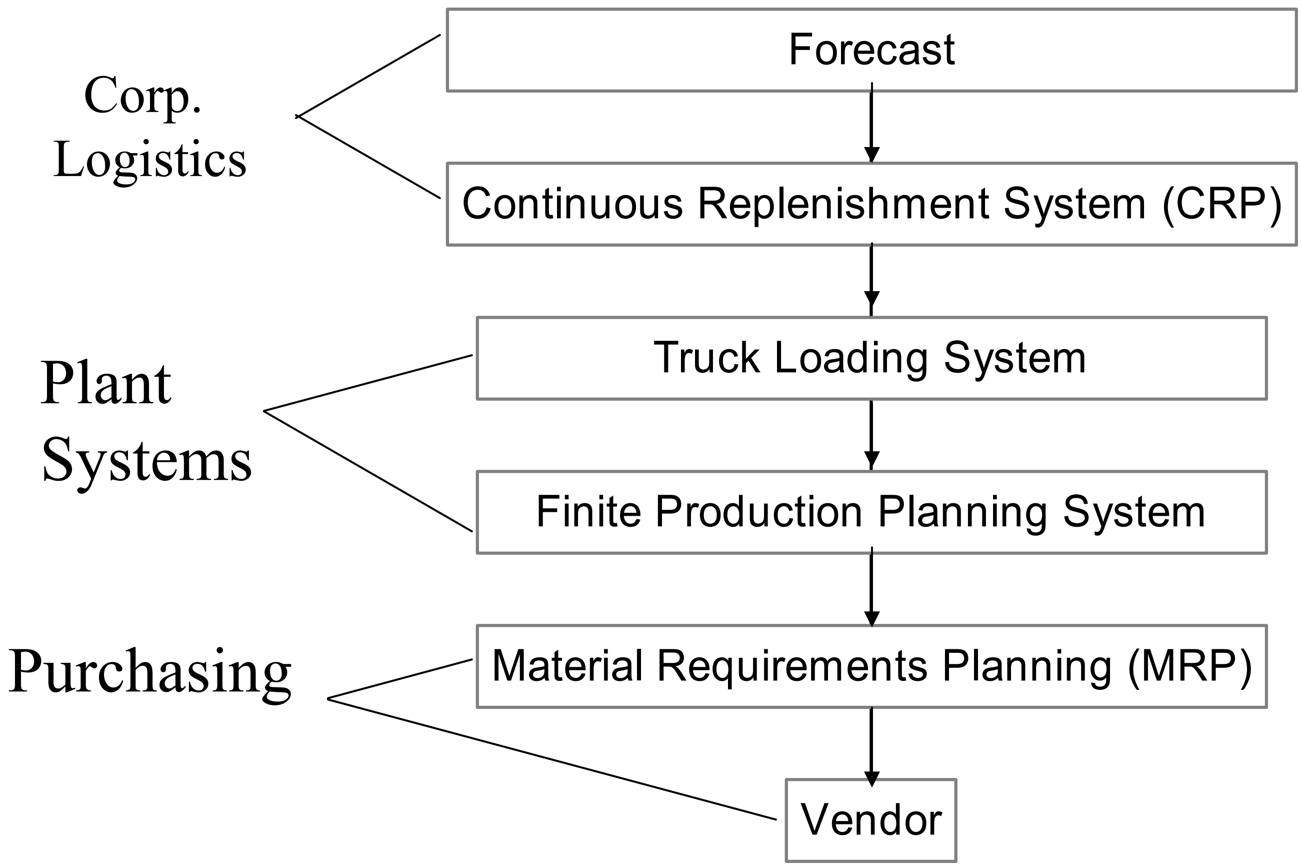
Manufacturing Cycle



Order Cycle Time



SUPPLY CHAIN PLANNING SYSTEMS



NETWORK PLANNING

- Number and location of plants, vendors, DC's
- Distance to customer
- Long-term expansion or contraction

THE IMPORTANCE OF NETWORK PLANNING

- Complex problem; timing, size, location
- Long lead-time for equipment additions
- Large capital expenditures
- Uncertain long-term demand projections
- Financial attractiveness versus risk

IMPORTANT SUPPLY CHAIN REFERENCES

- Arntzen, B.C.; Brown, G.G.; Harrison, T.P.; Trafton, L.L., 1995, **"Global Supply Chain Management at Digital Equipment Corporation,"** *Interfaces*, Vol. 25, no. 1, January-February.
- Camm, J.D.; Chorman, T.E.; Franz, A.D.; Evans, J.R.; Sweeney, D.J.; Wegryn, G.W., 1997, **"Blending OR/MS, Judgement, and CIS: Restructuring P&G's Supply Chain,"** *Interfaces*, Vol. 27, no. 1, January - February.
- Geoffrion, A. and Powers, R., 1995, **"Twenty Years of Strategic Distribution System Design: An Evolutionary Perspective,"** *Interfaces*, Vol. 25, no. 5, September - October.
- Lee, H. L. and C. Billington, 1995, **"The Evolution of Supply Chain - Management Models and Practice at Hewlett Packard,"** *Interfaces*, Vol, 25, no. 5, September - October.

STRENGTHING GLOBAL EFFECTIVENESS: P&G APPROACH TO SUPPLY CHAIN ANALYSIS

- Streamline work process
- Drive out non-value added costs
- Eliminate duplication
- Rationalize manufacturing and distribution

PLANT CONSOLIDATION STRATEGY:

- Reduce manufacturing expense
- Reduce working capital
- Improve speed to market
- Avoid capital investment
- Fewer production line conversions because of new reformulation
- Eliminate the least productive sizes
- **REDUCE COMPLEXITY**

REASONS P&G CONSIDERED RESTRUCTURING

- Deregulation of trucking
- Trend toward product compaction
- Total quality, higher through-put and greater reliability of each plant
- Decrease in product life cycles
- Excess capacity in the system

WHAT P&G LEARNED

- Hard to develop an single model of the supply chain
- Mfg. And raw material costs dominated distribution costs by a large margin
- Sourcing decisions more sensitive to customer locations than DC locations
- Visual approach is the only way to do static modeling of the supply chain

NETWORK OPTIONS AT WELCH'S

- Tune-up existing plants
- Public warehousing
- Private warehousing
- New manufacturing plants
- Co-packer (contract) arrangement
- Focused manufacturing
- Combination strategy

CUSTOMER SERVICE ISSUES

- Process-oriented firms tend to locate near raw material sources; however, retail stores want short order cycle time
- Customer Service defined:
  - % of time in stock (Type I)
  - Cases ordered vs. cases Shipped (Type II)
  - Distance to customer (avg. miles)

VERTICAL INTEGRATION

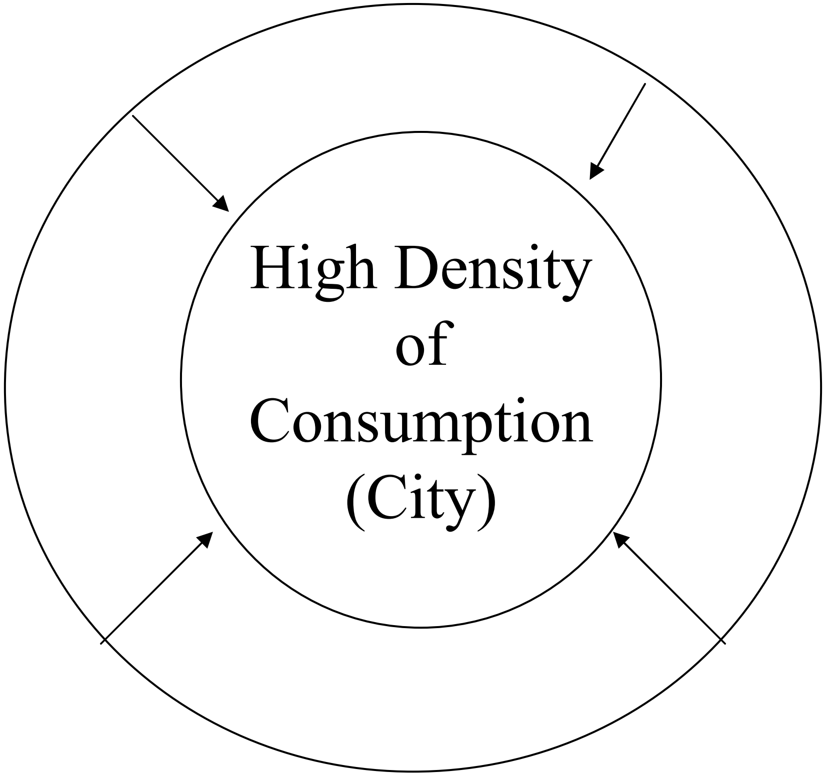
- Stages of the Production Cycle
  - Basic Producer
  - Converter
  - Fabricator
  - Assembler

BILL OF MATERIAL STRUCTURE

Process	Discrete
V	A
Few raw materials, high volume	Many raw materials, Low volume

von Thunen's Belts

- Early theory on location of agricultural production
  - Profit = Market price -(production cost + transportation cost)
  - Agriculture locates in an area that maximizes profit



Low value,
High weight
Agricultural
commodities

ANALYTICAL TECHNIQUES FOR NETWORK PLANNING

- <u>Optimal Methods:</u>
- Find the minimum of a total cost equation subject to constraints

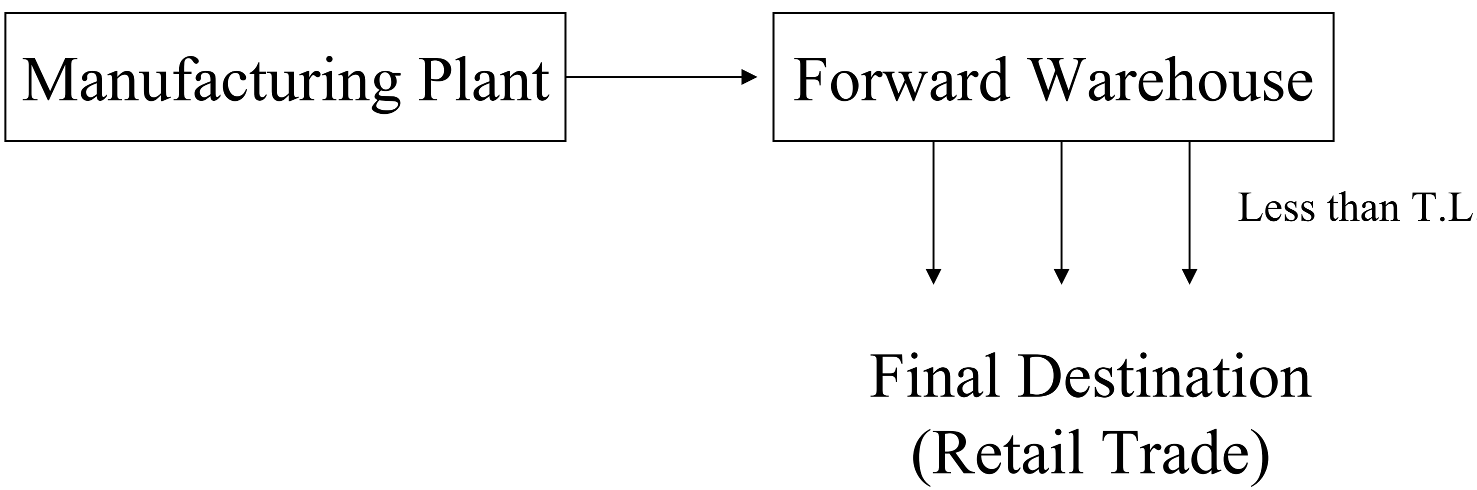
Spreadsheet optimization

- Linear programming
- The transportation problem
- The trans-shipment problem
- Non-linear programming
- Network flow programming

ANALYTICAL TECHNIQUES FOR NETWORK PLANNING (cont.)

- Simulation Methods:

  Sometimes use probability distributions to approximate cost through time. An experienced analyst can manipulate parameters to obtain a near optimal solution



ANALYTICAL TECHNIQUES FOR NETWORK PLANNING (cont.)

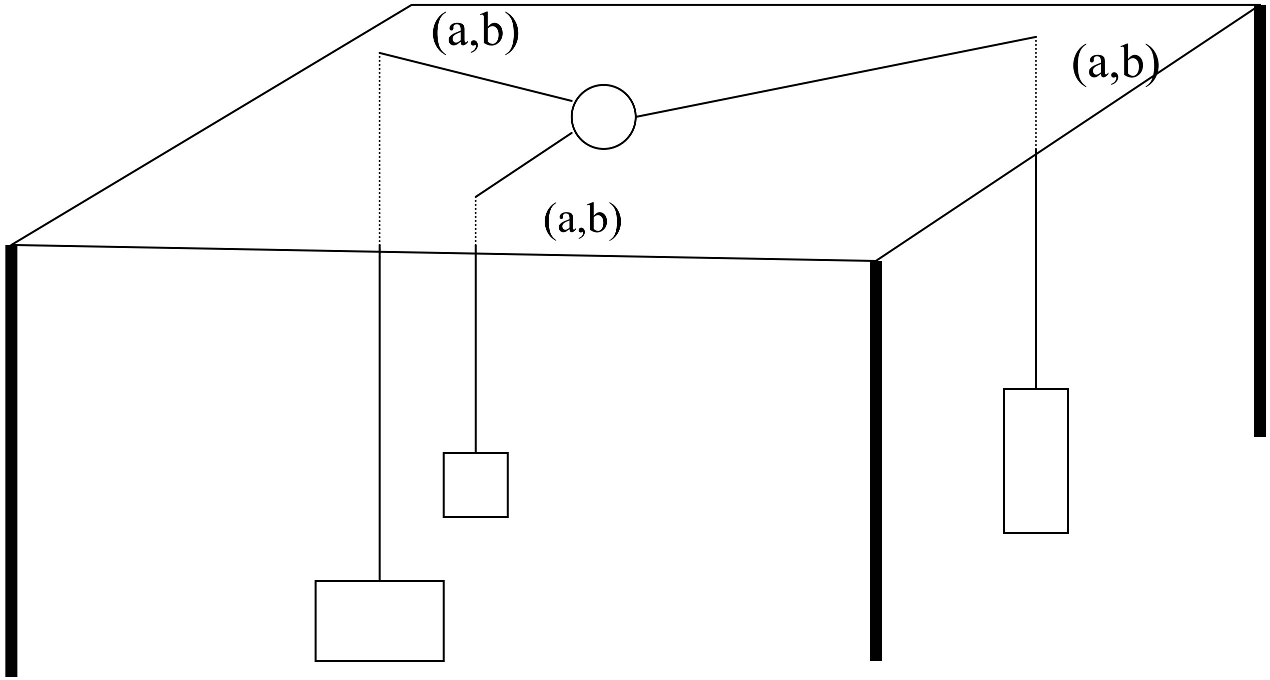
- **<u>Heuristic Methods:</u>**
- Defined as "rules of thumb", heuristics serve to reduce the average time to search for a solution
- Kuehn-Hamburger
  - Locations with the greatest promise are those located near concentrations of demand
  - Near optimal warehousing systems can be developed at each site if the warehouse with the greatest cost savings is added
  - Only a small subset of all possible warehouse locations needs to be evaluated to determine which warehouse should be added.

WAREHOUSE NETWORKS CLOSEST TO THE U.S. POPULATION

# of Warehouses in the Network	Shortest Av. Dist. to the U.S. Population	Best Warehouse Location
1	821	Terre Haute, IN
2	470	Chillicothe, OH Fresno, CA

Source: Chicago Consulting

Physical Model of Euclidean Distance Problem



$$\min f(x.y) = \sum_{i=1}^{n} w(i)\sqrt{(x-a(i))\char`^2 + (y-b(i))\char`^2}$$

Requires an iterative procedure

DYNAMIC CAPACITY EXPANSION POLICY
An Optimal Solution

- Develop a cost function for plant expansion
- Take the first derivative with respect to the decision variable
- Set to zero
- Find optimal plant size and time interval between expansions

Manne, A.S. (ed.), 1967, “Investments for Capacity Expansion: Size, Location and Time Phasing,” Cambridge, MA; The MIT Press.

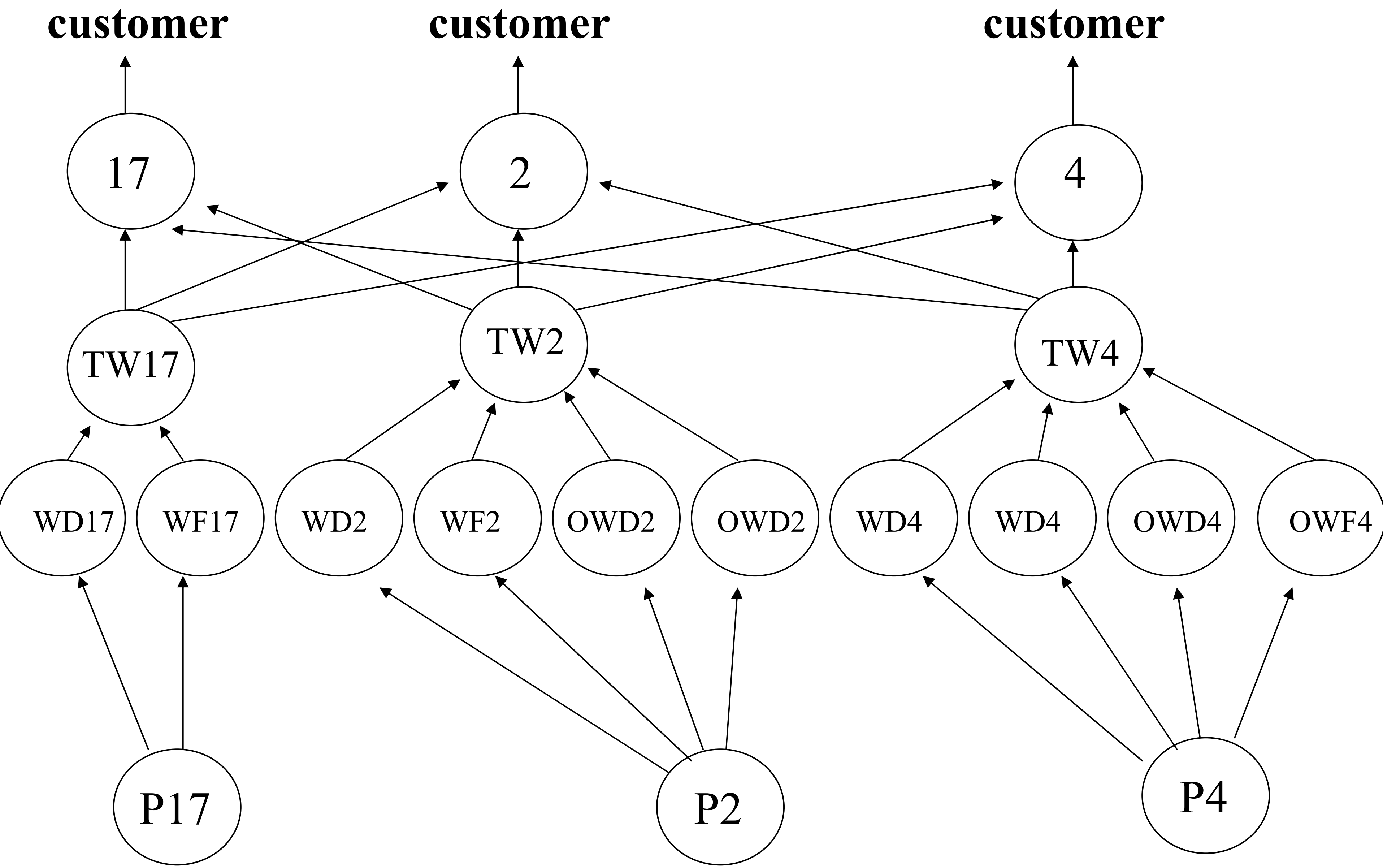
Welch’s Approach to Network Planning

- **LOCATE4 (CSC, Inc.)** - Distribution planning software, Linear Programming and Least Cost Simulation
- PC Based, Windows (written in FoxPro)
- Costs include: production, fixed, transportation, warehousing and inventory
- Multi-echelon, static network planning
- Aggregate production capacity considered

NETWORK MODELING ISSUES

- Data gathering
- Product group structure and aggregation concerns
- Production costs, standard versus actual
- Raw material costs
- Transportation rate information, commodity flows and lane capacity

The Welch Supply Chain



SYMBOL KEY

P = Plant

WD = Inside warehouse dry

WF = Inside warehosue frozen

OWD = Outside warehosue dry

OWF = Outside warehosue frozen

TW = mixing warehouse (dummy node)

17 = Kennewick, WA

2 = Lawton, MI

4 = North East, PA

HISTORY OF LOCATE APPLICATION

- Run first models in 1990
- Two major plant location studies
- Change the assignment of products to plants
- Change the assignment of territories to plants
- Evaluate “product platforms”

RECENT NETWORK MODELING RESULTS

- Shift service to Georgia from PA Plant to MI plant
- Single serve platform - 85% of demand in the West comes from only six cities
  More 2.5 times more single serve sold in NYC than the entire state of Texas
- Renegotiate rates with house carriers
- Change consolidation patterns

SUPPLY CHAIN DYNAMICS AT WELCH'S

- Capacity becomes very important in all production and inventory management decisions
- Changes in demand ripple through the supply chain
- Finite capacity systems must exist in all levels of planning
- Production planning versus MRP

CHARACTORISTICS OF A "GOOD" SOLUTION

- Use costs of set-ups and inventories as a criterion
- When a set of demands is infeasible:
  - -Indicates which periods require additional capacity
  - -Provides a schedule for the revised capacity
- Accessible
  - -Can be implemented in EXCEL7.0 spreadsheet
  - -Does not require specialized math programming software of knowledge
- Permits "what-if" analysis in terms of cost consequences
- Provides schedules without excessive computer time

METHOD SELECTED

- Rule based method (heuristic)
- Modified Dixon-Silver Heuristic (1981)
  - -Provides good solutions for zero set-up times
  - -Conceptually simple
  - -Easy computations
  - -Modest computer resource requirements
  - -Uses the proven Silver-Meal (1973) lot-sizing method
- Modifications Required:
  - -Account for set-up times
  - -Detect infeasible demand patterns
  - -Implement in an EXCEL 7.0 environment