Inventory Control

Description:

Analysis of deterministic and stochastic inventory models;

Lot size models and their extensions;

Reorder point determination,quantity discounts;

The Wagner-Whitin algorithm;

Newsvendor (single period and two period models);

Period review and Multi-echelon models.

Textbook:

S. Axsäter, Inventory Control, Kluwer,2000

Course Content

- Introduction
- Batch Quantities for Deterministic Demand
- Time varying demand (Wagner-Whitin algorithm)
- Decision & Forecast Horizons
- Safety Stock and Reorder Points
- Joint Optimization of Order Quantity and Reorder Point
- Optimality of Base-Stock Policies
- Optimality of (s,S) Policies
- Power-of-Two Policies
- Production Smoothing & Joint Replacement
- Inventory Model with Markovian Demand
- Forecasting
- Implementation

Introduction-I

Inventory everywhere:

- my desk drawer
- piles of coal in a Tokyo steel plant
- supply room, retail stores
- vast global network of industry
- inventories in transit
- inventories in the service industries
- immense scale, $1.1 billion in March 1999 in the USA

Introduction-II

- Customer do not easily forgive shortage of delivery delays
- Inventory management critical to a firm's strategic viability
- Success stores in retailing (Wal-Mart), auto (Toyota), computer (Dell) are founded on operational capabilities that among other things keep inventories lean
- Amazon.com

  - operation without huge inventory

  - innovation in inventory management enabled by technology

Importance of Inventories-I

- Inventories present about 1/3 of our total investments, and as a result are extremely significant
- The total amount of inventories in the U.S was $243.5 billion in 1970 and $1.1 trillion in March 1999; that is 1.35 times their total monthly sales
- Following the inventory recession of 1920s, Dun and Bradstreet issued a book describing numerous cases of business failures resulting from inventories
- Businessmen have developed an almost “pathological fear of increasing inventories.” (Whitin)

Importance of Inventories-II

- This fear has had the effect of reducing inventories in many firms to operating levels far below good inventory practice, which has lead to high operating costs.
- “Don’t expect your management to relinquish its belief in inventory turnover overnight. Years of use has given this tool far more stature than it rightfully deserves.” (Evert Welch)
- Product diversification has increased the number of parts to control; these number literally in tens and hundreds of thousands.

Introduction to Inventory Control-I

- Supply Chain Management:

  control of the material flow from supplier to customers is a crucial problem

- Total investment in inventories is ENORMOUS

- Huge potential for improvement to cut cost, to gain competitive advantage

⇒ **Importance of Inventory Management**

Introduction to Inventory Control-II

- Balancing conflicting goals of Finance, Production and Marketing
- Finance: keep stocks low to free up investment capital
- Purchasing: order large batches to get volume discounts
- Production: long production runs to avoid time-consuming setups and have a large raw material inventory to avoid production stoppages
- Marketing: have high stock of finished goods to avoid stockouts

$\Rightarrow$ **Inventory Models seek to find the best balance between these goals.**

Independent Demand Inventory Models-I

- **Introduction**

  The average manufacturing company spends over one-half of its sales revenue on inventory. Because of the large investment and expenditure required for acquiring and controlling inventories and their effect on profits, successful companies devote a great deal of attention to inventory management.

- **How much inventory is enough?**

  - Marketing department wants large inventory, it does not like stockouts.

  - Finance department likes low inventory and high turnover to minimize funds tied up in inventories; opportunity cost of capital.

Independent Demand Inventory Models-II

- Production department likes to keep production costs low. It likes uniform production and long uninterrupted runs of a small number of products.

Inventory models attempt to consider the cost of stockouts and lost sales, the cost of funds tied up in inventories and the cost of set-ups and to balance these cost as as to minimize the total cost.

Inventory Management-I

- **Inventory:** An idle resource of any kind that has potential economic value
  - raw materials
  - component parts
  - work-in-process
  - finished products, etc.
- **Reasons for carrying inventory**

1) To provide service
   - finished good inventory to meet demand and keep customers happy
   - work-in-progress inventory to increase flexibility by decoupling production stages and keep machines running
   - raw material inventory keeps production moving
   - protection against uncertainty

Inventory Management-II

2) To save money

- buying in large quantities allows spreading of fixed costs such as ordering costs and obtaining quantity discounts.
- stocking of seasonal items allow production smoothing or work-load balancing.

- "The aborigine knew nothing of inventory control, and, quite possibly his 20th century corporate counterpart is equally as unenlightened. The changeover from inventory to inventory control bears no date. Some concerns plunged into the healthful waters of scientific management of inventories well before the first world war. Others are still on the shore contemplating on the advisability of wetting their toes. (Benjamin Melnitsky).

Inventory Management-III

- **History**

1915 F.W.Harris (Westinghouse)
Lot size formula (EOQ model); independently developed by Wilson and sold to many companies as an integral part of an inventory control scheme.

1931 F.E. Raymond (MIT)
Wrote the first full length book.

WWII Christmas tree problem (Newsboy problem)
Whitin's stochastic extension of the EOQ model.

Early Computer made it possible to handle large data requirement

1950's Of the inventory models, Whitin published a book on stochastic inventory models in 1953.

Inventory Management-IV

1958	Arrow, Karlin and Scarf published their now classical book, which is a definitive work on inventory theory, inspired a great deal of research for next decade.
Mid	Material requirement planning (MRP)
1970's	Books by Orlicky, Wight in 1974

Inventory Problem-I

- Solve for
  1) When should an order be placed?
  2) How much should be ordered?

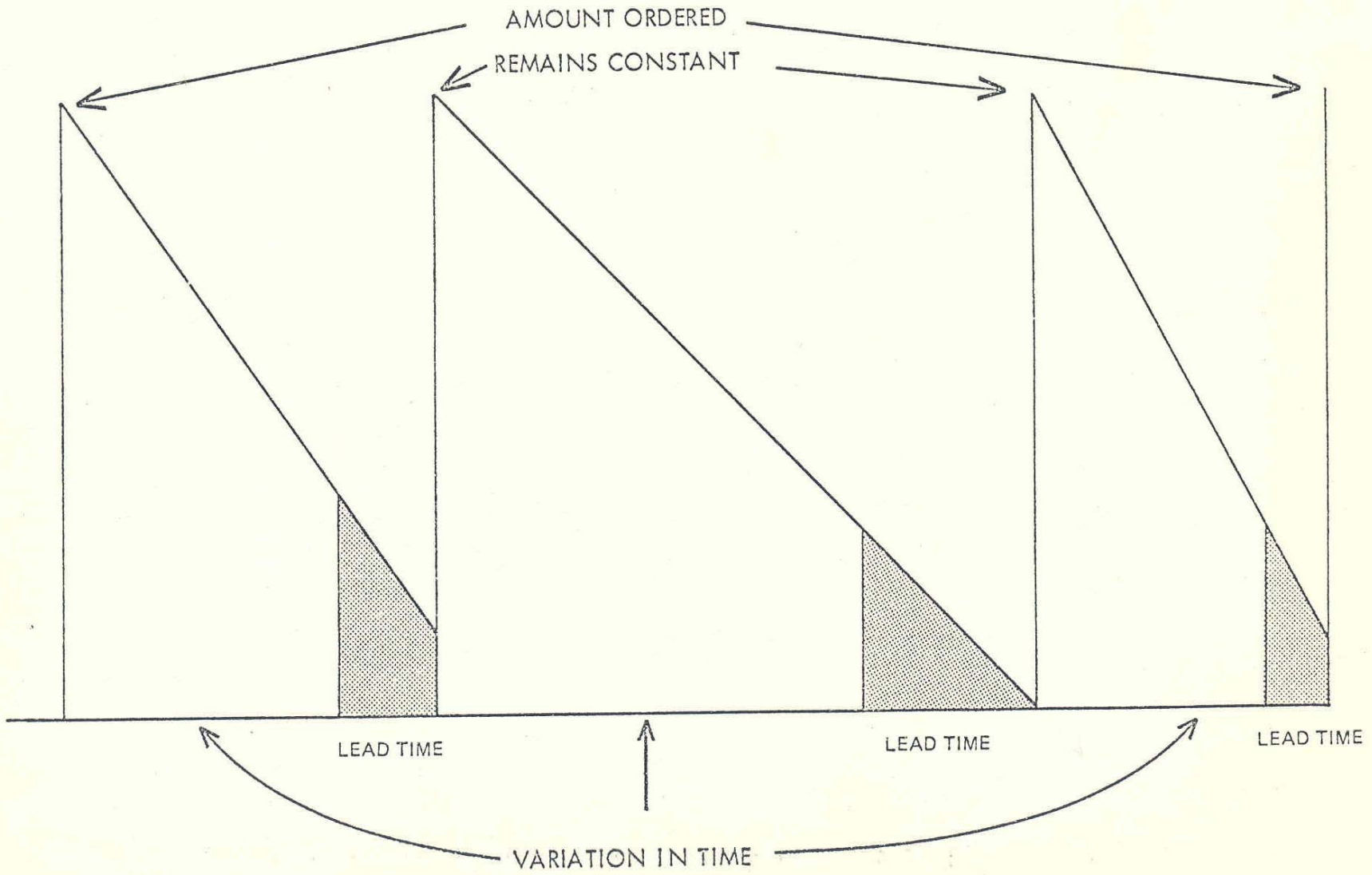
  in order to minimize the costs

- Applications
  - raw materials, intermediate products, finished goods
  - capacity planning (e.g., hospital beds)
  - cash management

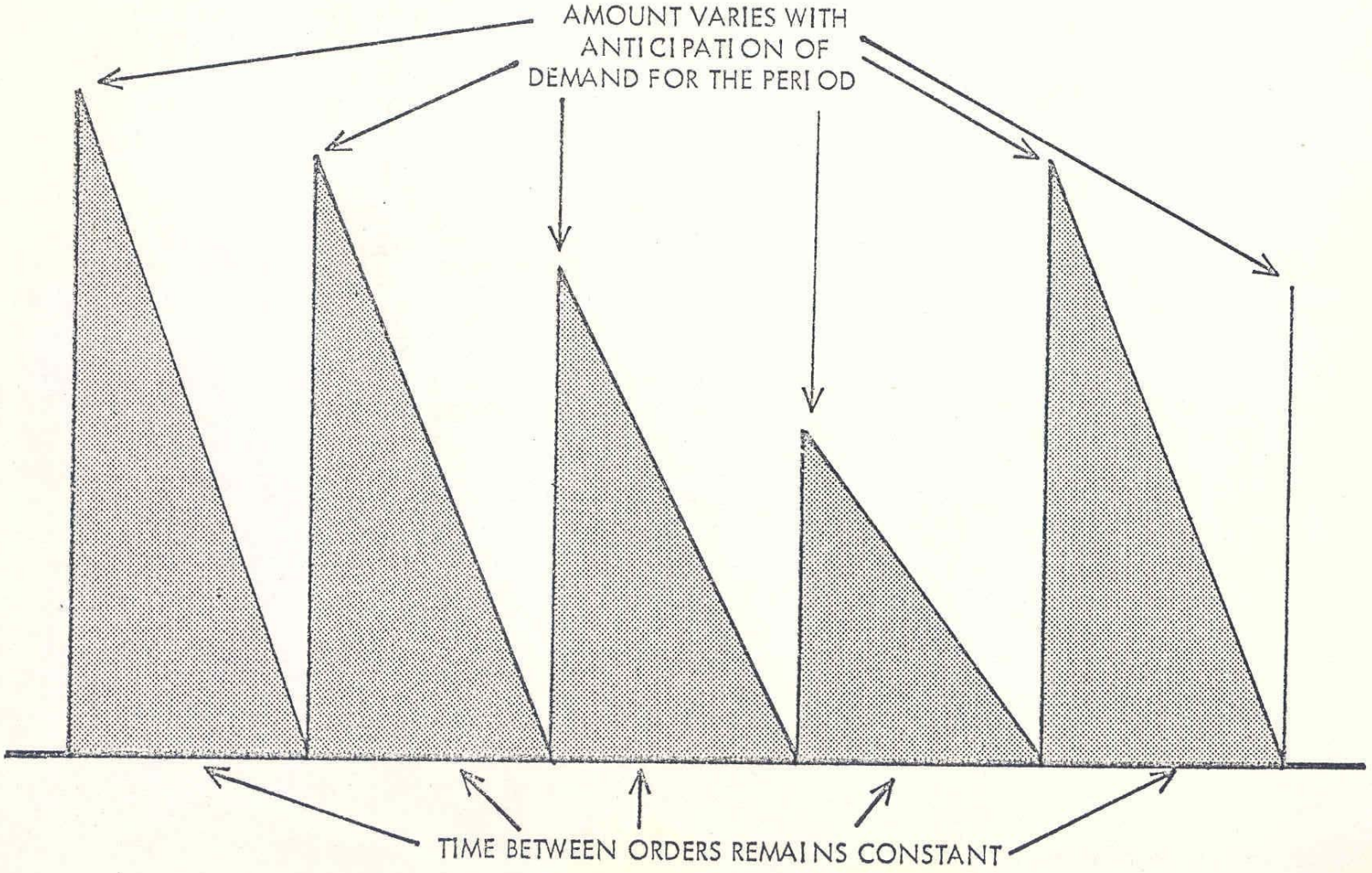
Inventory Problem-II

- Types of inventory systems
  - Order point planning (OPP)
  - Fixed-Quantity system (Trans, 5-1)
  - Fixed-Interval system (Trans, 5-2)
  - Minimum-Maximum System, (s,S)-system
  - Material requirement planning (MRP)
  - Kanban or just-in-time system

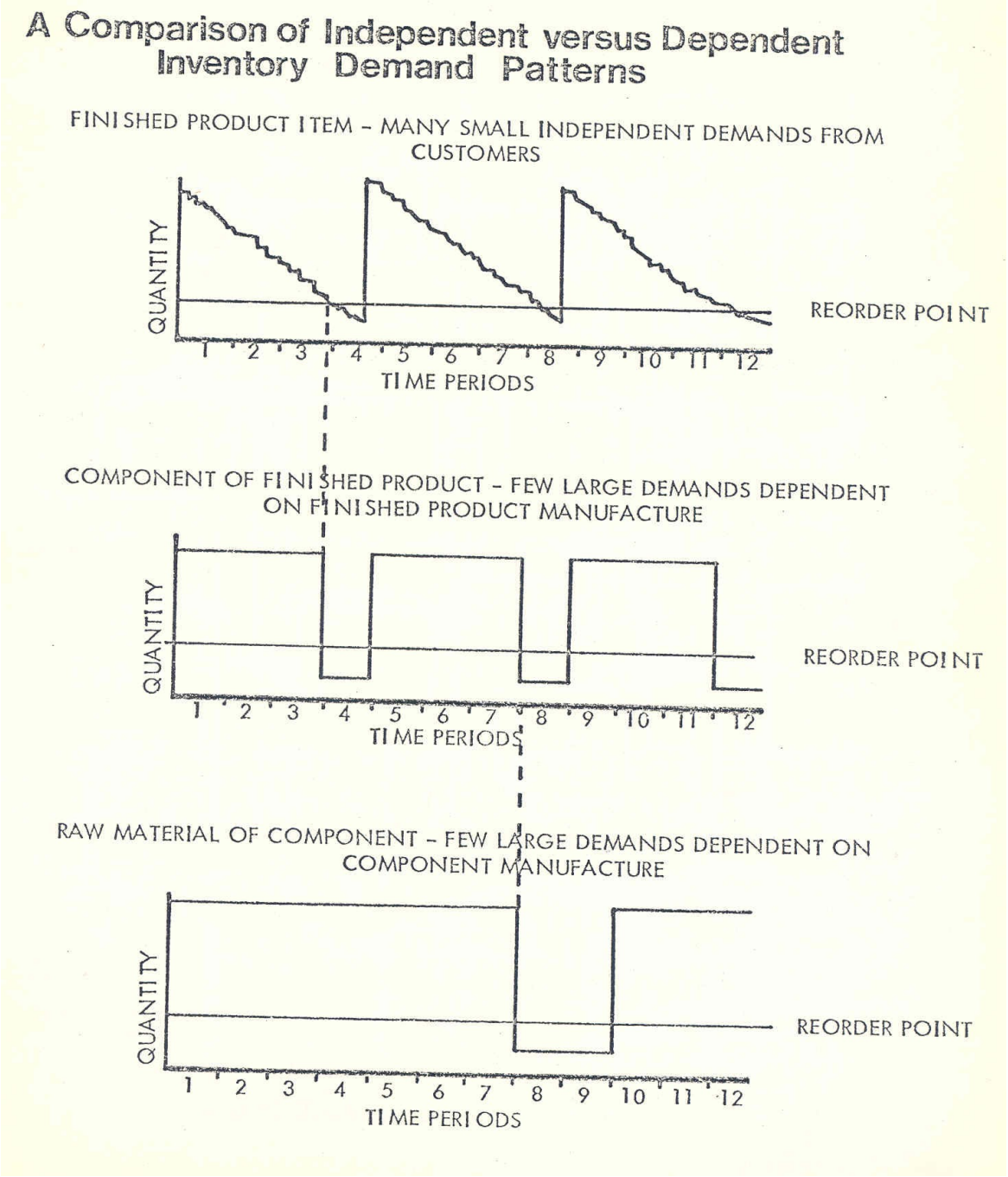
A FIXED ORDER QUANTITY INVENTORY REORDER SYSTEM



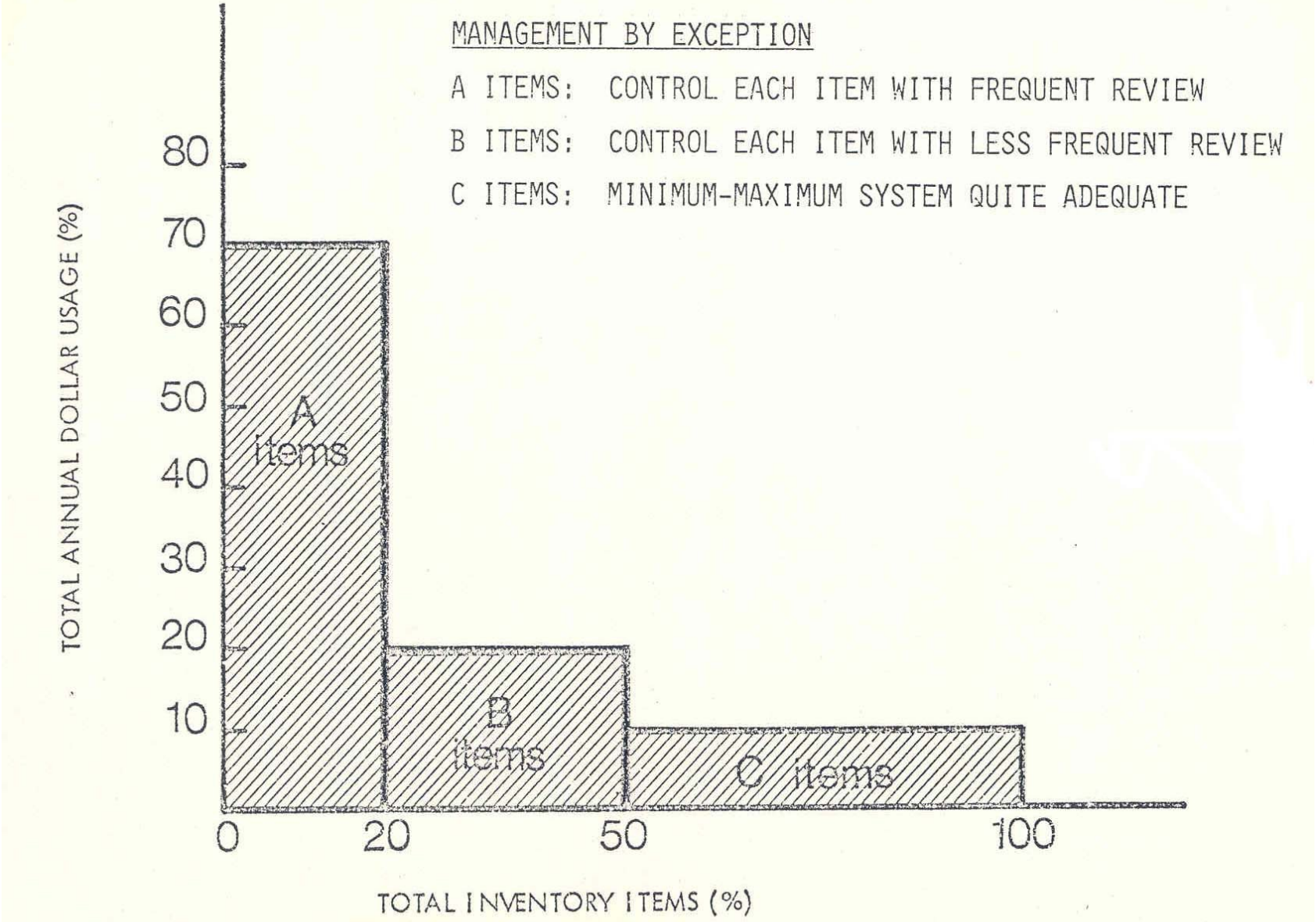
A Fixed Interval Inventory Reorder System



A Comparison of Independent versus Dependent Inventory Demand Patterns



TYPICAL DISTRIBUTION OF THE ABC INVENTORY ANALYSIS



General Framework for Inventory Models-I

- **Demand**
  - certainty
  - risk, probability distribution of demand
  - uncertainty, nothing known
- **Lead time:** The period between the order time and the delivery time
  - certainty
  - risk, probability distribution of demand
  - uncertainty
- **Inside or Outside Procurement**
  - purchased from outside; pure inventory problem
  - integrated with production smoothing if inside

General Framework for Inventory Models-II

- **Static and Dynamic Problems**
  - Static: one period problem, classic examples are
    Christmas tree and newsboy problem
  - Dynamic: decisions over time
- **Behavior of Demand through Time and for Various Items**
  - Stationary Demand: EOQ models
  - Time-dependent Demand: WW model, Silver/Meal Heuristic
  - Dependent Demand: MRP

General Framework for Inventory Models-III

- **Costs**
  - Price or Variable Production Costs: quantity discounts
  - Ordering or Setup Costs
  - Holding or Inventory Carrying Costs
  - Stockout/Shortage costs

General Framework for Inventory Models-III

- Information technology allows us to easily keep and update information
- Simple inventory system can include:
  - forecasting module
  - determination of order points and order quantities
  - monitoring of inventory levels
- Costs
  - holding costs including opportunity costs
  - ordering or setup costs
  - shortage costs or service levels
- Capacity Constraints
  - demand distribution
  - lead times

Will not consider speculative costs.