Optimization-Based Available to Promise

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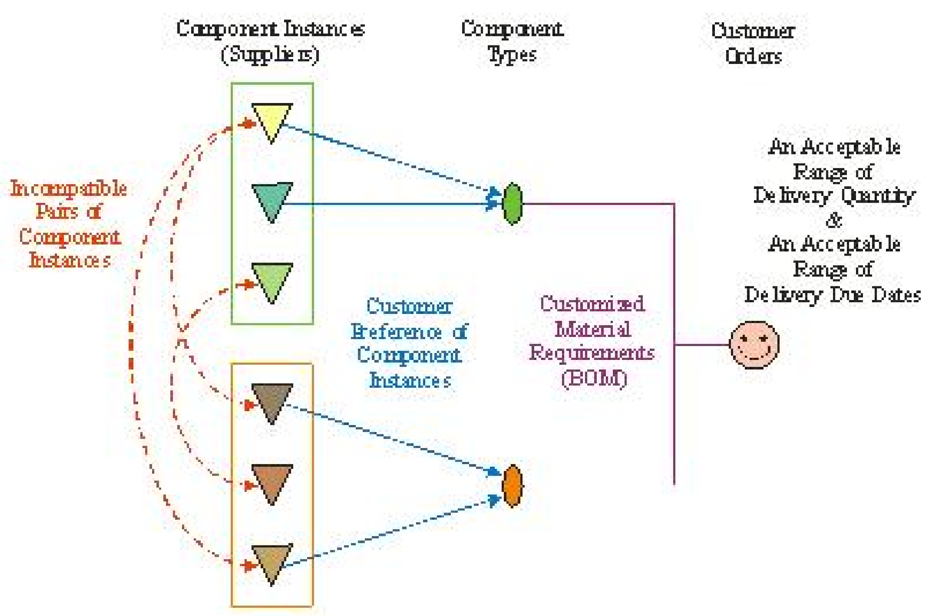
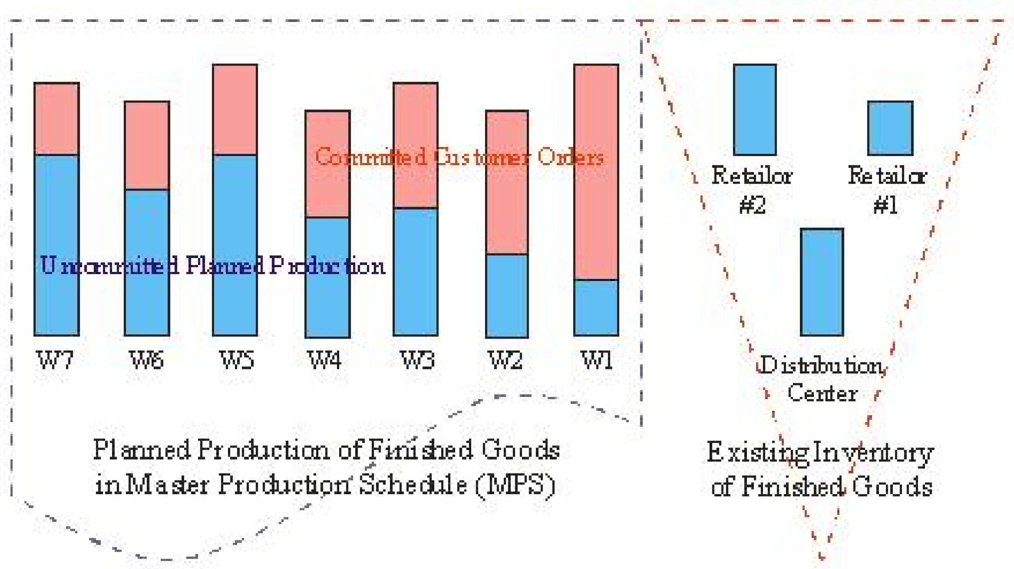
ATP Problem Description

- An ATP system coordinates *front-end customer orders* and *back-end logistics/production ability*
- Order Promising and Order Fulfillment Decisions:
  - Which due date to promise? How much quantity to promise?
  - Which production schedule to use? Which components to use?
- Customer Order and Material Compatibility



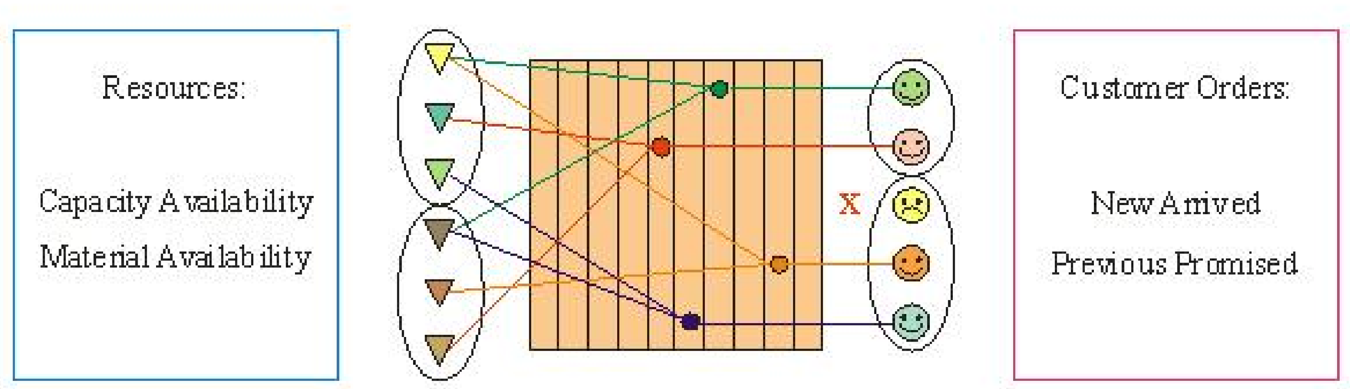
Conventional ATP

- A bookkeeping function in MPS that keeps track of uncommitted portion of finished goods in forms of existing inventory or planned production



Advanced ATP

- *An execution mechanism that allocates and re-allocates available resources, including raw materials, work-in-process, finished goods, and even production and distribution capacities, in response to actual customer orders*
- In an assembly-to-order (ATO) environment, ATP matches available resources (capacity and materials) to customer orders



Multiple Criteria

- Order Profitability – long-term vs. short-term profit
- Customer Priority – important vs. regular customers
- Customer Satisfaction – response time vs. delivery time
- Production Efficiency – resource utilization

Major Decision Variables

- Z^i = order acceptance indicator, 0/1, for order i
- $D^i(t)$ = delivery time indicator, 0/1, for order i at time t
- $C^i(t)$ = quantity promised to order i at time t
- $P^i(t)$ = quantity produced for order i at time t
- $X^i_{j,k}(t)$ = component (j,k) used for order i at time t

MIP Formulation

- Objective Function
  - Maximize: (net revenue) – (production cost) – (material cost) – (inventory cost) – (order denial penalty) – (capacity under-utilization penalty)
- Constraints
  - Order commitment constraints
  - Material requirement constraints
  - Material compatibility constraints
  - Production capacity constraints
  - Production smoothness constraints
  - Inventory balance constraints

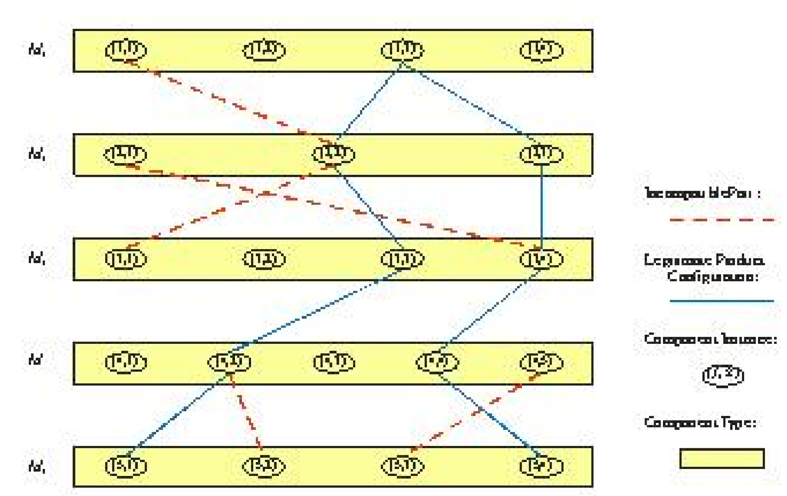
Compatibility Constraint

- Product-configuration Approach – a huge set of D.V.'s
- Component-consumption Approach

$$\sum_{k \in R} X^i_{j,k}(t) \le \frac{b_j}{b_{j'}} \cdot \sum_{k' \in \Gamma_{j,j'}(R)} X^i_{j',k'}(t)$$

where $\Gamma_{j,j'}(R)$ denotes the subset of type- j' component instances in $M_{j'}$, which are compatible with *some (at least one)* type-j component instances in R

- We prove that this set of compatibility constraints is necessary and sufficient for "level-structured" incompatibility

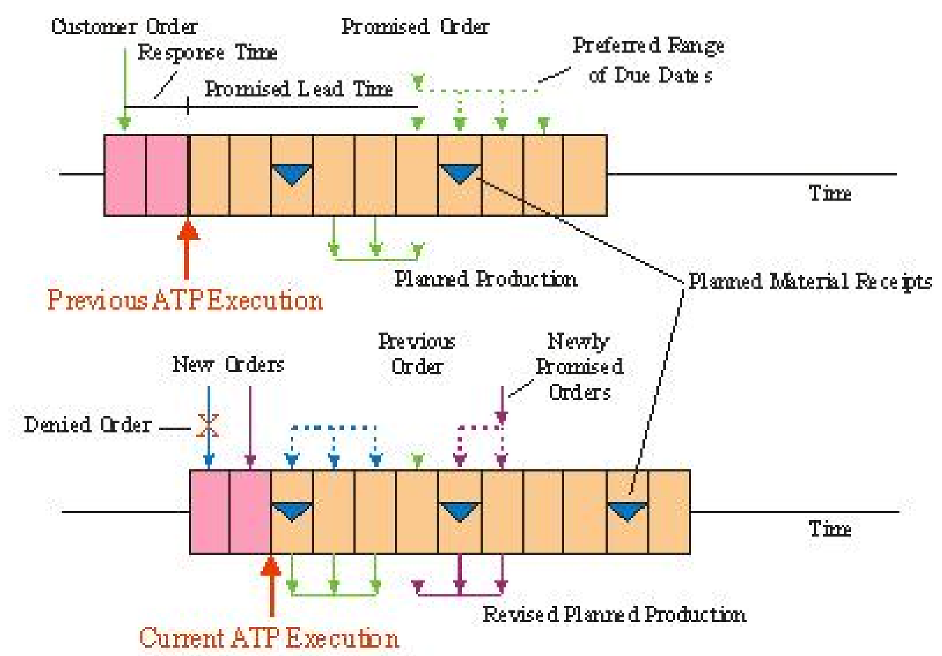


Batch Mode vs. Real-Time Mode

- Real-Time Mode – response and order commitment given for each customer order *immediately* after order receipt
- Batch Mode – customer orders collected over a predetermined "*batching interval*" (e.g., one hour, 8-hour shift, one day); response and order commitment generated for a batch of orders at the end of each" batching interval."

ATP Rolling Horizon

- In batch mode, ATP is executed periodically to process new orders arrived during the batching interval. The due date and quantity of each previous promised order should be respected; however, the associated production schedule and material utilization can be modified to accommodate new orders.



Experiment Results

- Experiment 1 – Maxtor Hard Disk Drive (only quantity quoting)

- Experiment 2 -- Toshiba Notebook PC (due date and quantity quoting)