

Problem Overview

Given Information

Supply Chain

- Topology & Capacities

Time Horizon

- 52 weekly periods

Demand (Weekly)

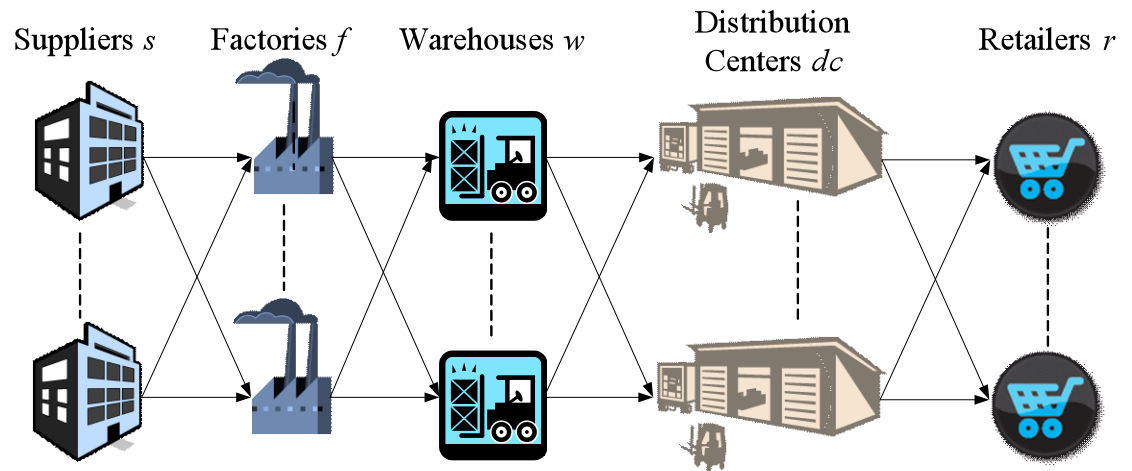
Ingredient Availability

Recipes & Production Rates

Initial Inventories

Economic costs

- Transportation Costs
- Storage Costs
- Safety Stock Costs
- Set-up Costs
- Missed Sales Costs



Determine

- Procurement from each supplier
- Production at each factory
- Transportation between all facilities
- Inventories in all facilities
- Delivery of products to retailers

Tactical Planning Model

□ MILP Model

- **Objective: Minimize Costs**

- **Main Constraints**

- Procurement capacity
- Production capacity
- Inventory balance
- Safety stock
- Missed sales

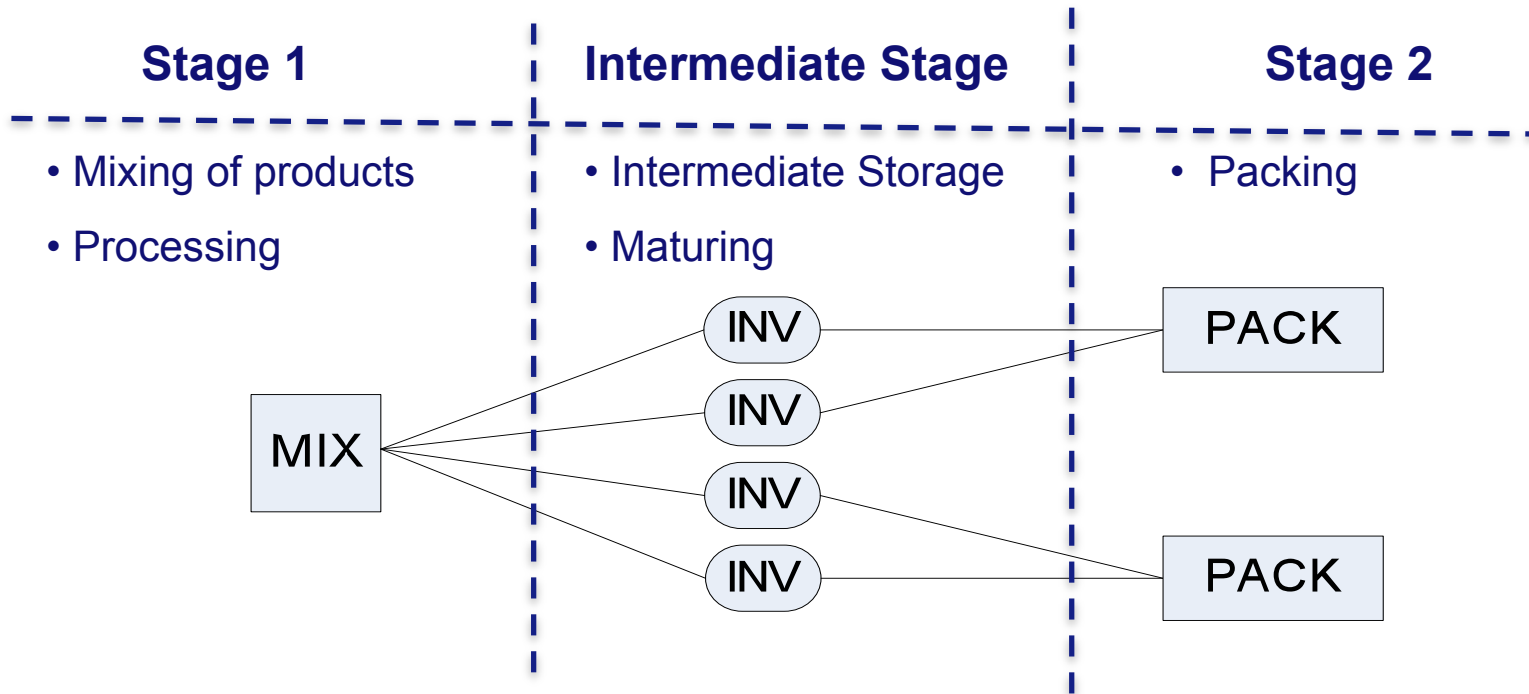
- **Main Variables**

- Procurement, production, transportation and inventory (Continuous)
- SKU Set-up (Binary)



Production Process

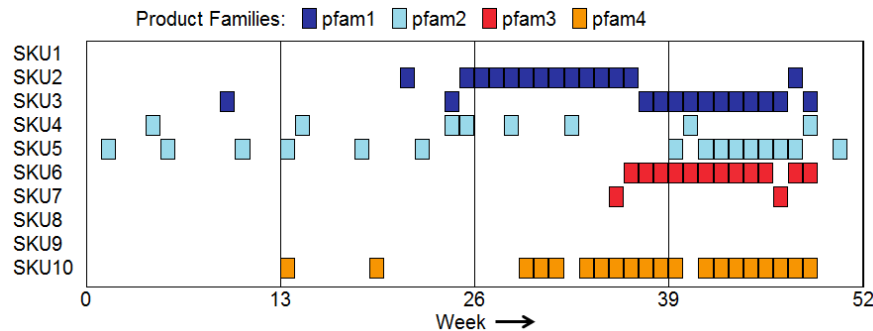
□ Two stage make-and-pack process



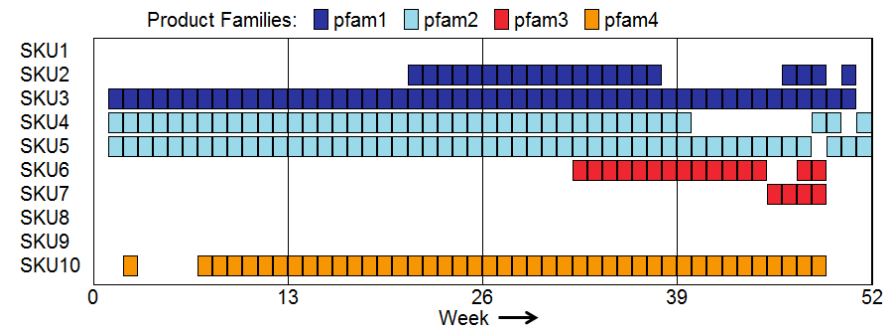
Results

Production plan

With set ups



Without set ups



- 8% increase in costs due to many changeovers
- Infeasible plan

Full model Intractable for realistic cases

Case	CPU time	Opt. Gap	Variables (binary)	Constraints
10 SKU	1hr 14m	0.36%	185,589 (2,080)	41,809
50 SKU	12 hr	No solution	826,229 (10,400)	170,769

SKU Decomposition Algorithm

□ Single SKU Model

- Limit domain of all variables/constraints to single SKU
- Solve for all SKUs consecutively

□ Modified Capacity Constraints

$$WHinv_{i,w,t} + \sum_{i' \neq i} WHinvP_{i',w,t} \leq WHcap_{w,t} + \beta_{w,t} \quad \square \quad i, w, t \mid i = \text{SKU}$$

Slack Variable

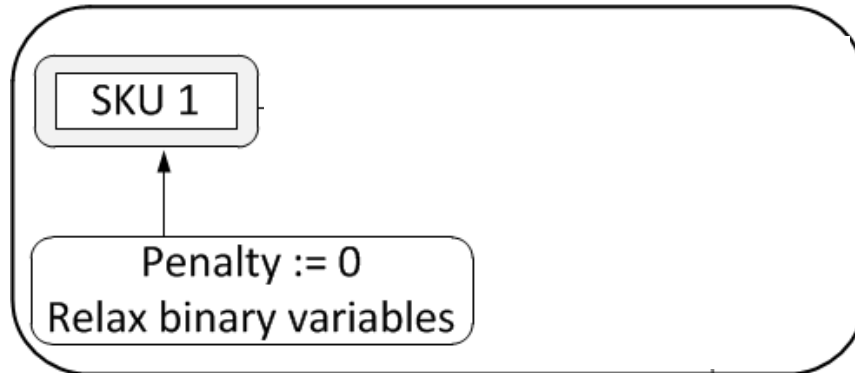
Current SKU variable Other SKU Parameters

- Slack variable allows initial capacity violation
- Slack variable added to objective with penalty cost
- Obtain feasible solution by slowly increasing pen cost

SKU Decomposition Algorithm

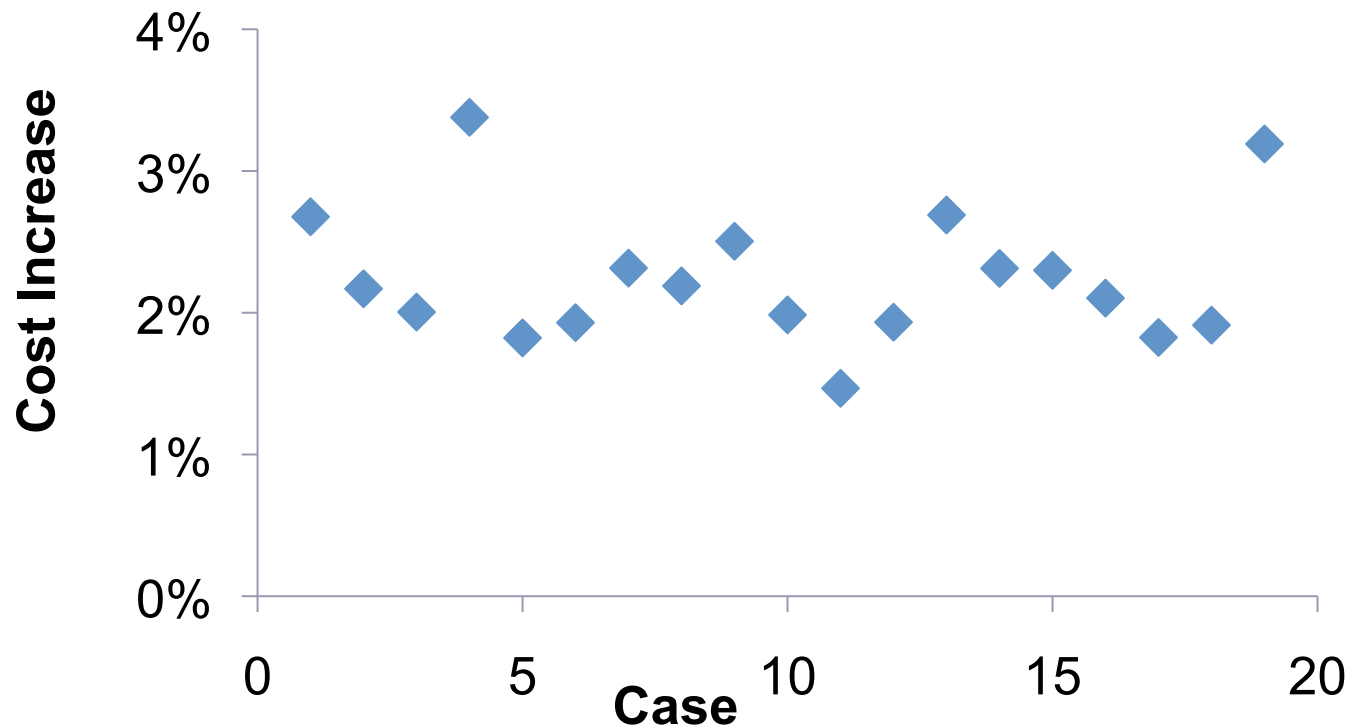
Decisions are:  fixed  variables

Step 1: Obtain an initial solution



Results

- Cost increase of algorithm compared to full model

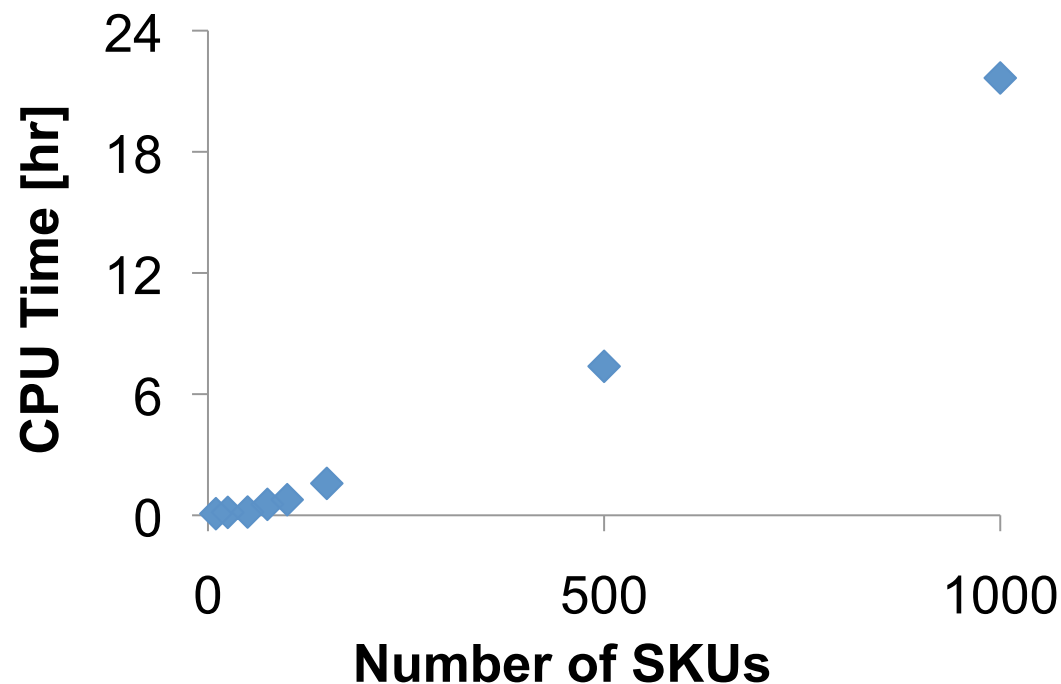


- Cost increase only 1.5-3.5%



Results

- Required computational time of algorithm



- Cases containing up to 1000 SKUs were solved!



Conclusions

- ❑ Full space model intractable for realistic cases
- ❑ Cases up to 1000 SKUs can be optimized with algorithm
- ❑ Solution of the algorithm are within a few percent of optimality

Questions

Thank you!

