



Carnegie Mellon

Tactical Planning in the FMCG Industry

Martijn van Elzaker
Peter Bongers
Ignacio E. Grossmann

EWO meeting, October 2011



Unilever

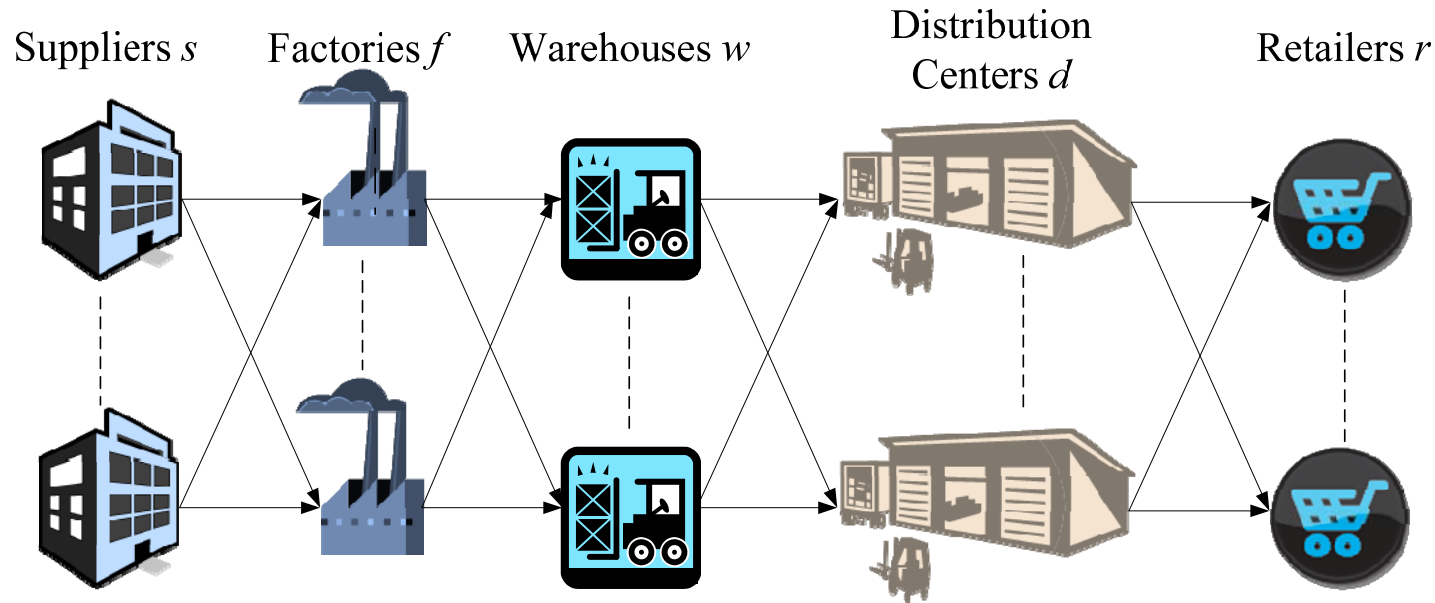
TU / e

Technische Universiteit
Eindhoven
University of Technology

Where innovation starts

Problem Overview

□ Supply Chain



□ Objective

- Find the optimal procurement, production and distribution plan
- Cost minimization

Challenges

- ❑ Large number of products
 - Up to thousands of SKUs per product category



- ❑ Seasonality of both products and ingredients
 - Weekly time periods over a 1 year horizon

➔ Extremely large MILP models

Approach: Product Decomposition Algorithm

❑ Single SKU Model

- Limit domain of all variables/constraints to single SKU
- Solve for all SKUs consecutively
- Would lead to capacity violations

❑ Updated Capacity Constraints

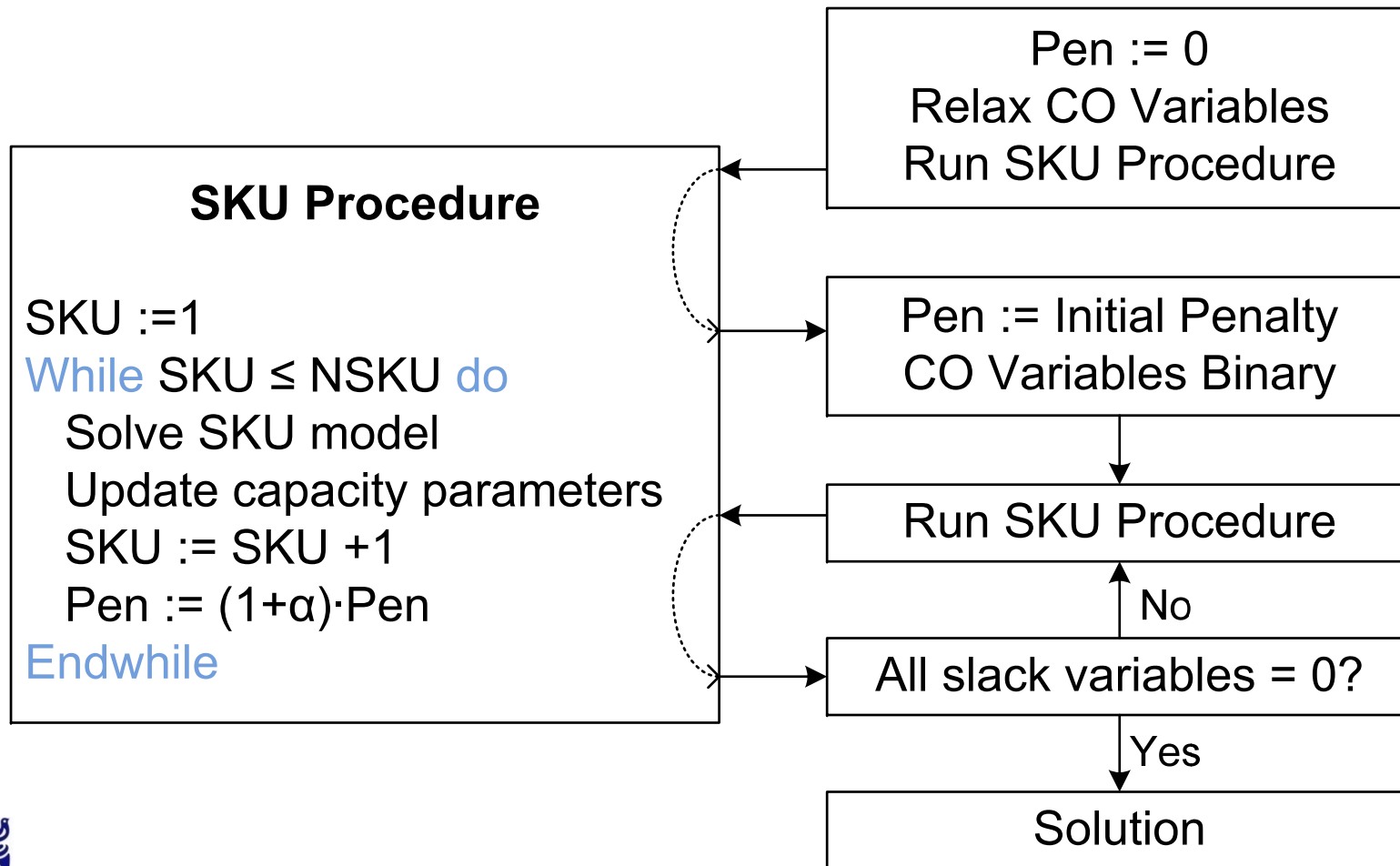
$$WHinv_{i,w,t} + \sum_{i' \neq i} WHinvP_{i',w,t} \leq WHcap_w + \beta_{w,t} \quad \forall i, w, t \quad | i = \text{SKU}$$

Slack Variable

Current SKU variable Other SKU Parameters

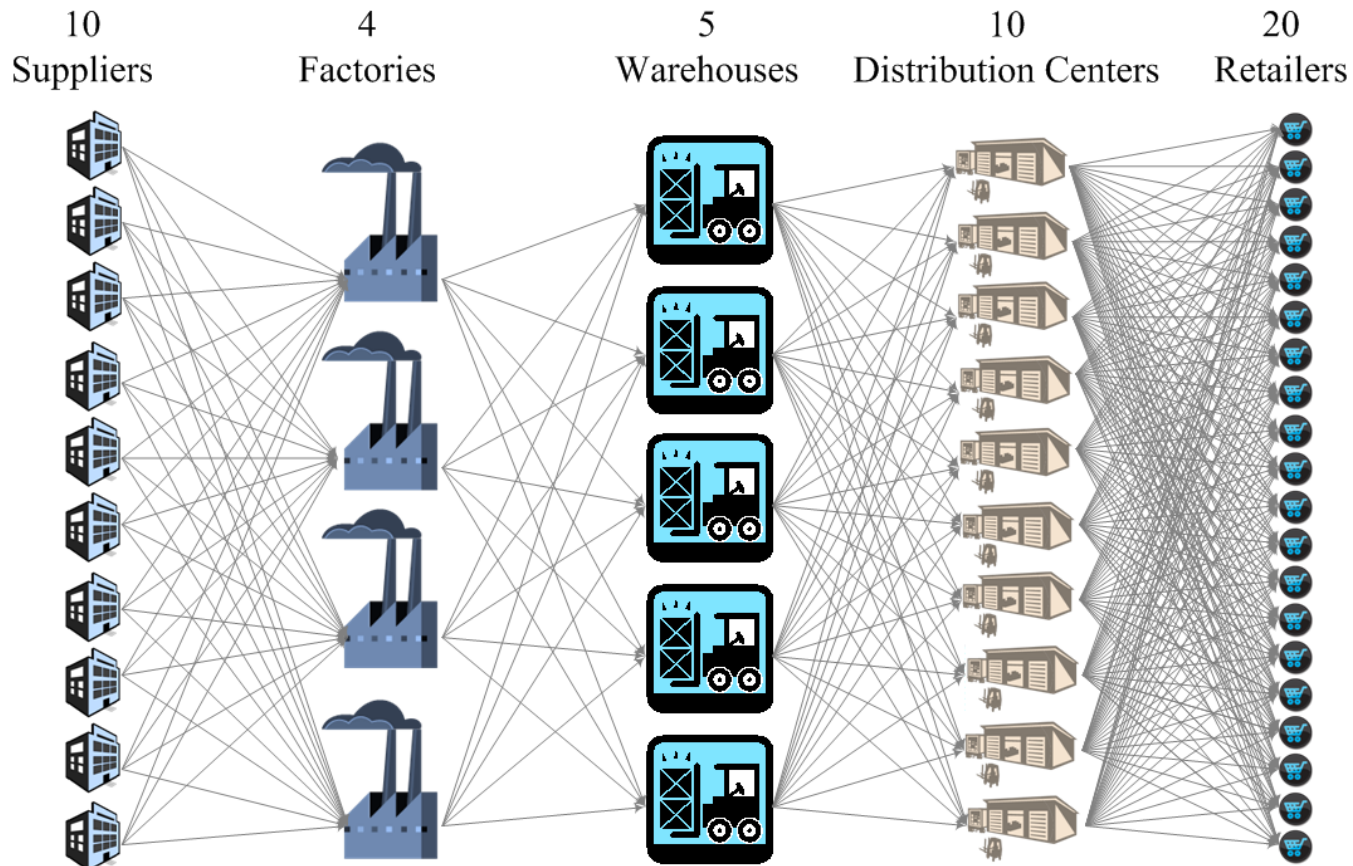
- Slack variable allows initial capacity violation
- Slack variable added to objective with penalty cost
- Obtain feasible solution by slowly increasing pen cost

Approach: Product Decomposition Algorithm



Results: Case study

□ Example cases set-up:



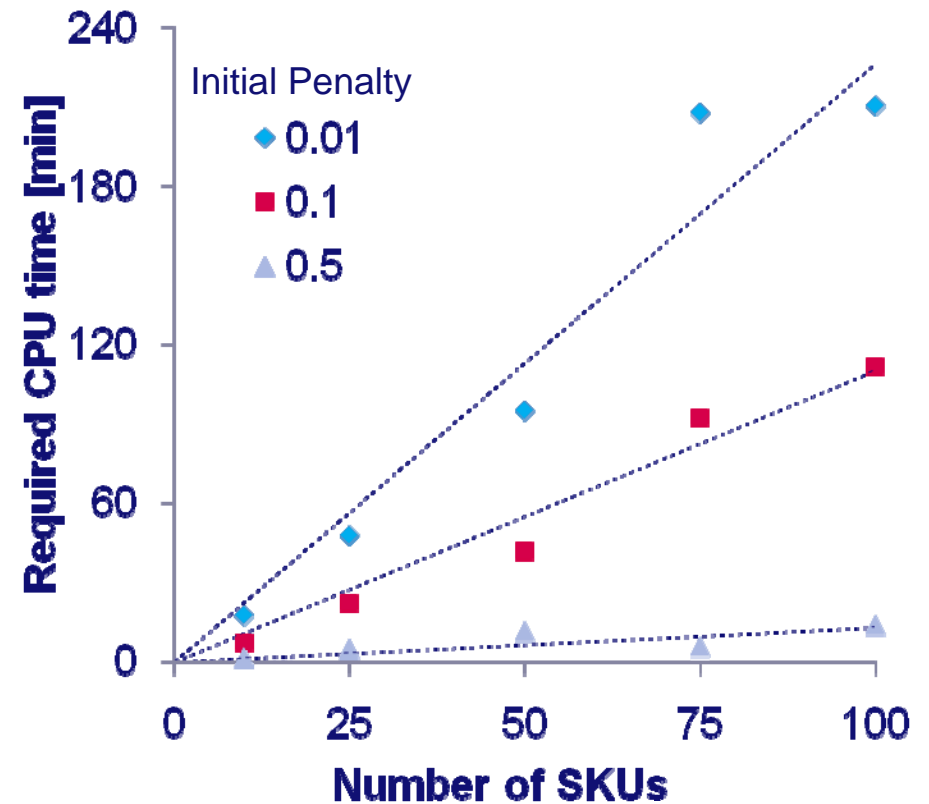
■ 10-100 SKUs, 10 ingredients

Results: Required CPU time

Full Scale Model

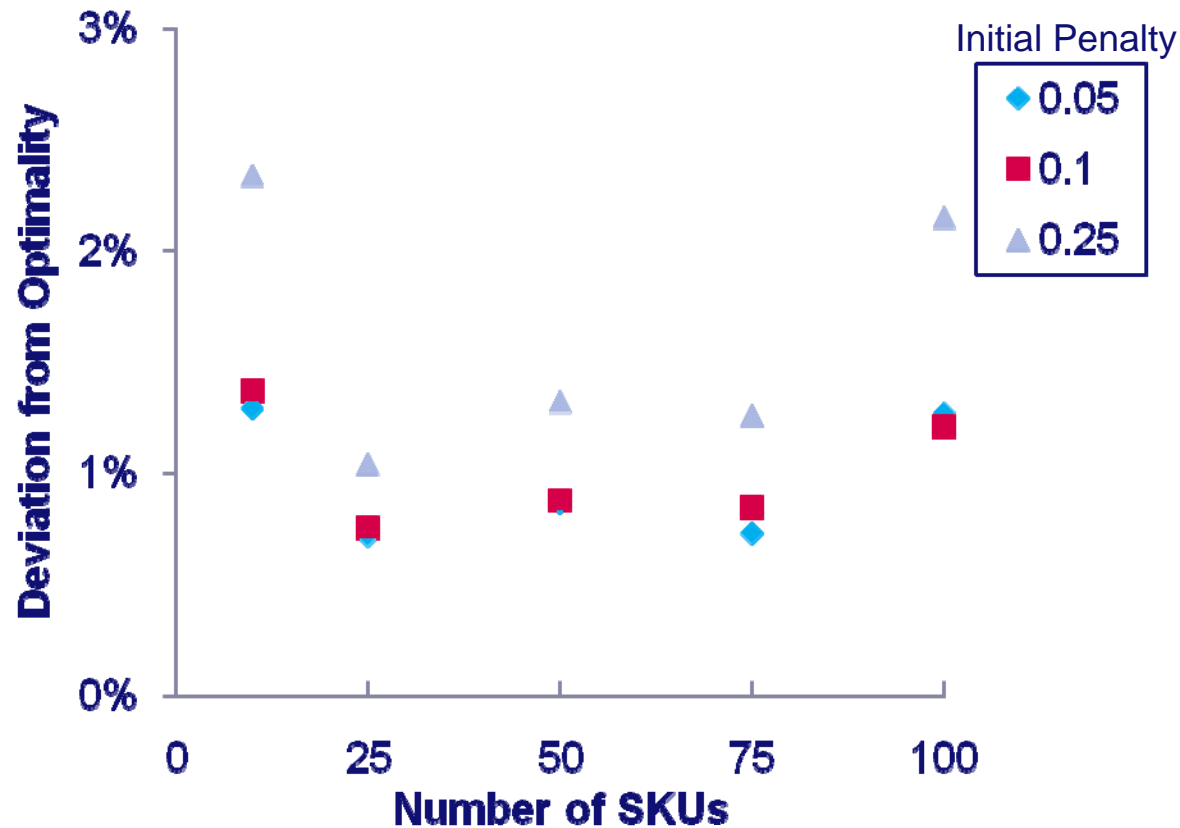
| <i>SKUs</i> | <i>Req. CPU Time</i> | <i>Deviation</i> |
|-------------|----------------------|------------------|
| 10 | 807 s | 0.3% |
| 25 | 6 hr | 1.5% |
| 50 | 6 hr | 83.8% |
| 75 | 6 hr | - |
| 100 | Memory Error | |

Algorithm



Results: Algorithm Deviation

- ❑ Penalty increase $\pm 10\%$ per iteration
- ❑ Relaxed Changeover Variables



Conclusions

- ❑ Full scale mid-term MILP planning models for the FMCG are intractable for realistic cases
- ❑ Product decomposition approach can obtain solutions within a few percent of optimality
- ❑ Required CPU time of product decomposition approach scales approximately linearly with number of SKUs