

Planning of a Network of Batch Plants with Blending

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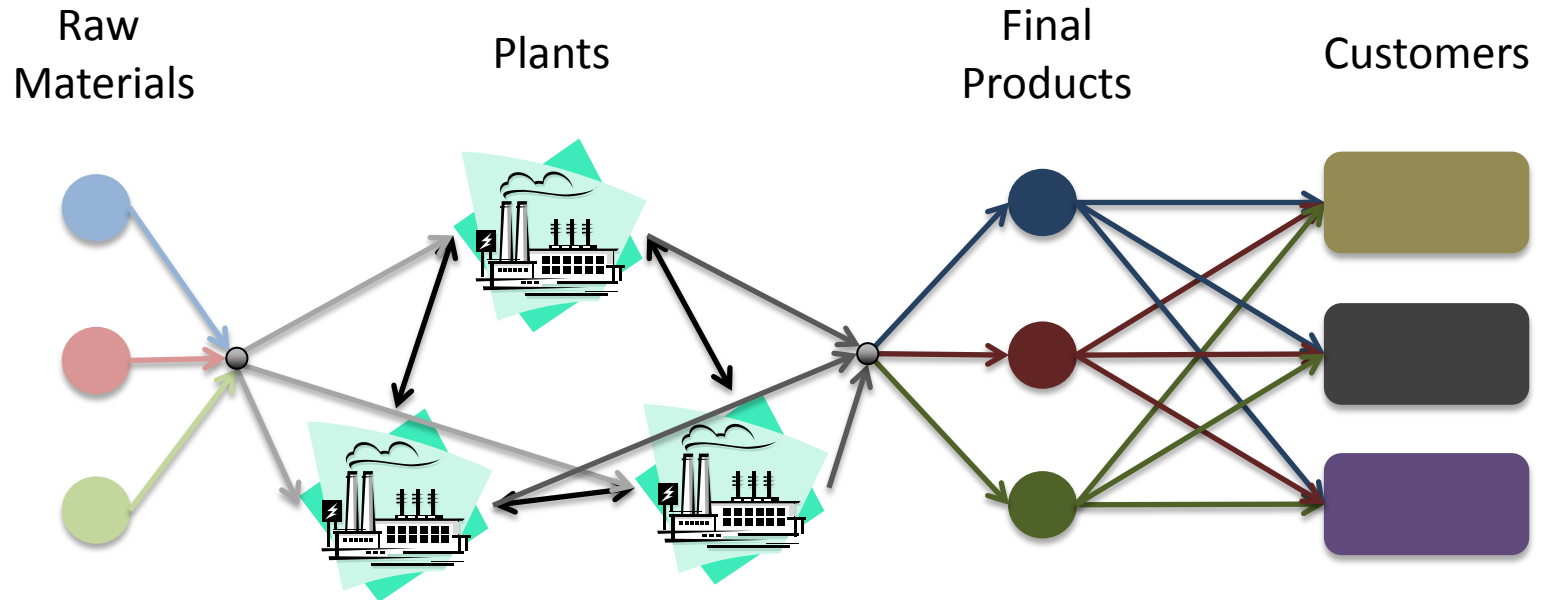
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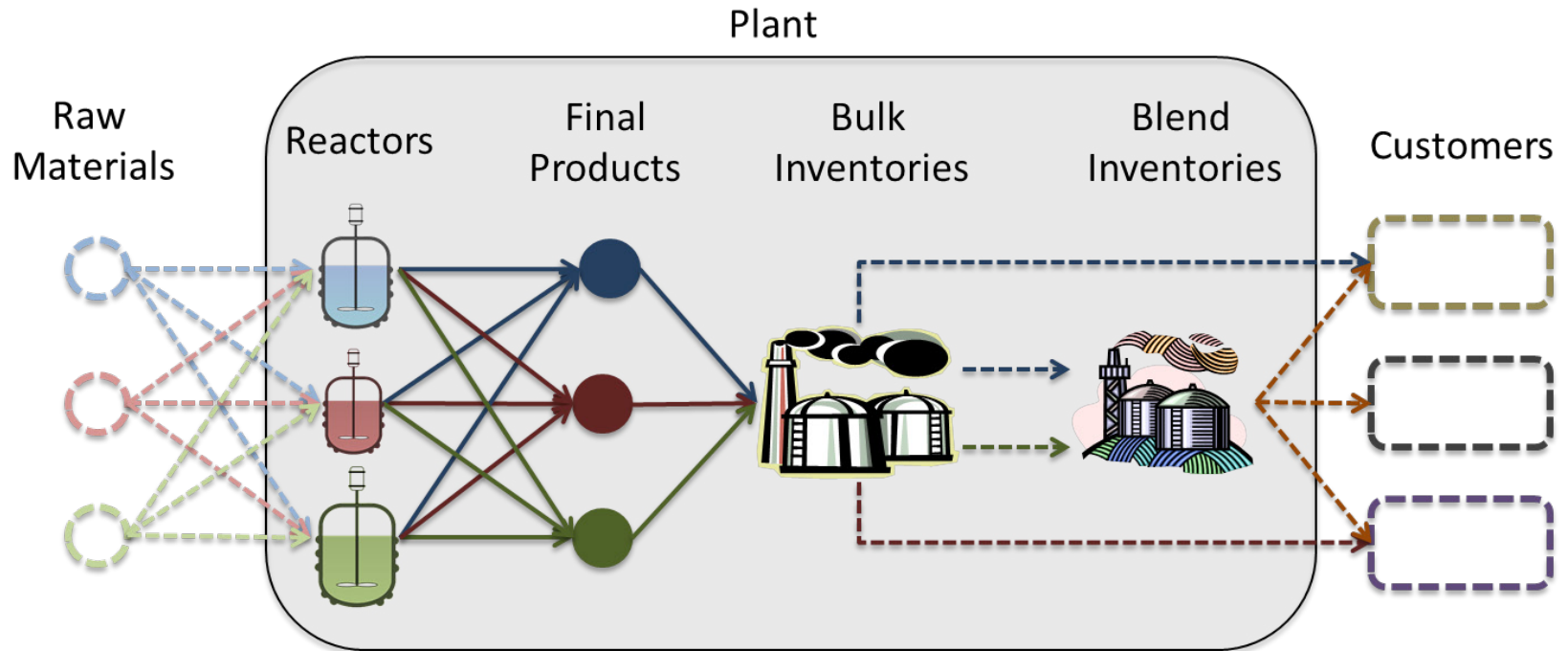
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Network Structure



- Products may be shipped **between** plants
- Intermediate products in one plant may be **blended** on the **same site** or on **another plant**
- Finished products **produced** in a given plant cannot be sold to customers in other plants

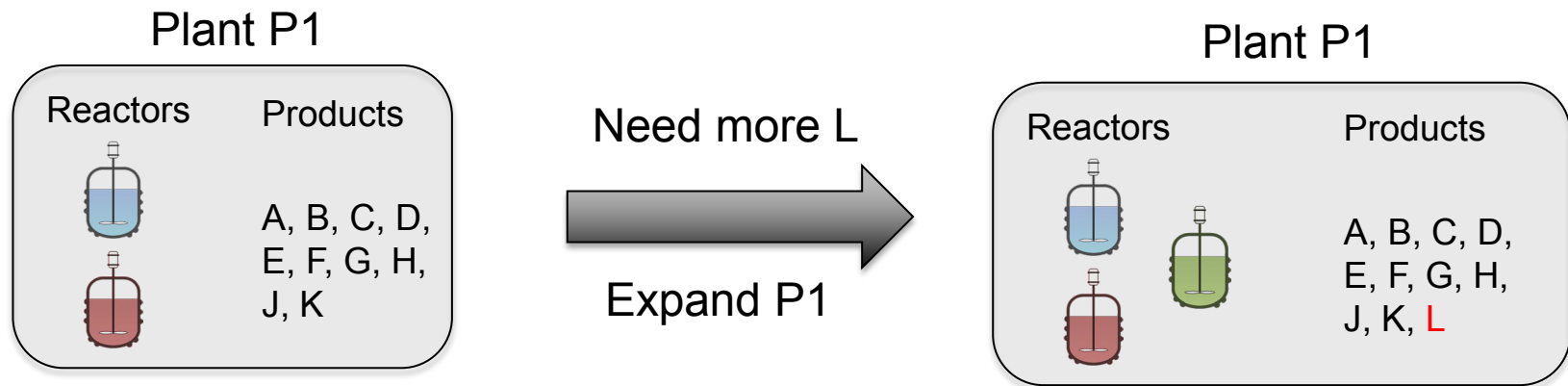
Multiproduct Batch Plants



- Batch units operating in **parallel**
- A subset of products are **blended**
- Blending ratios are **specified**
- Demands are specified **at the end** of time periods (months)

Option for Scale-Up

- Plants **cannot normally** produce all products
 - Operational restrictions
 - Some product-unit assignments are **incompatible**
- If **production** has to be **increased** in order to meet the demands
 - Determine the assignments of products to plants that did not produce them originally
 - Build **new units** in those plants
 - Compute the **fixed cost** due to the **scale-up**



Problem Statement

- **Given**

- Number of products to be produced (subset by **blending**)
- **Batch sizes** and **fixed processing times**
- Transportation and inventory costs
- Selling prices
- Forecast demands over a time horizon

- **Determine**

- **Production amounts** for each product in order to satisfy demands at each time period
- **Allocation** of products to units at each time period

- **Objective Function**

- Minimize: **Cost**
 - Operating, Transportation, Scale-up, Inventory costs

Model Characteristics

- Mixed-Integer Linear Programming (**MILP**) model
- Constraints
 - **Allocation of Products to Plants**
 - Activate scale-up decision 0-1 variables
 - **Time Balance**
 - Ensure the total production time is within the given time horizon
 - **Material and Inventory Balances**
 - Compute production amounts, inventory and backlogging levels, shipments between plants
 - **Plants Capacities**
 - Limit production amounts and number of scale-up decisions
 - **Demands Satisfaction**
 - Guarantee that sales equal the demands

Preliminary Results

- Small test case (2 plants, 10 products, 3 customers)
- Proposed model solution agrees with solution obtained in commercial software
 - **Proposed model** considers **integer** number of batches and **inventory costs**
 - Computational results

Discrete Variables	Continuous Variables	Equations	Non-zero Elements	CPU [s]
49	331	204	813	0.20

Future Work and Reference

- Test model on **larger instances**
- Introduce **sequence-dependent changeovers** (Erdirik-Dogan & Grossmann, 2007)
 - Analyze their impact in the economics and plants' capacities
 - Obtain schedule of products groups
- Reference
 - Erdirik-Dogan, M., & Grossmann, I. E. (2007). *Planning Models for Parallel Batch Reactors with Sequence-Dependent Changeovers*. **AIChE Journal**, 53(9), 2284-2300.