Case study “BASF2”

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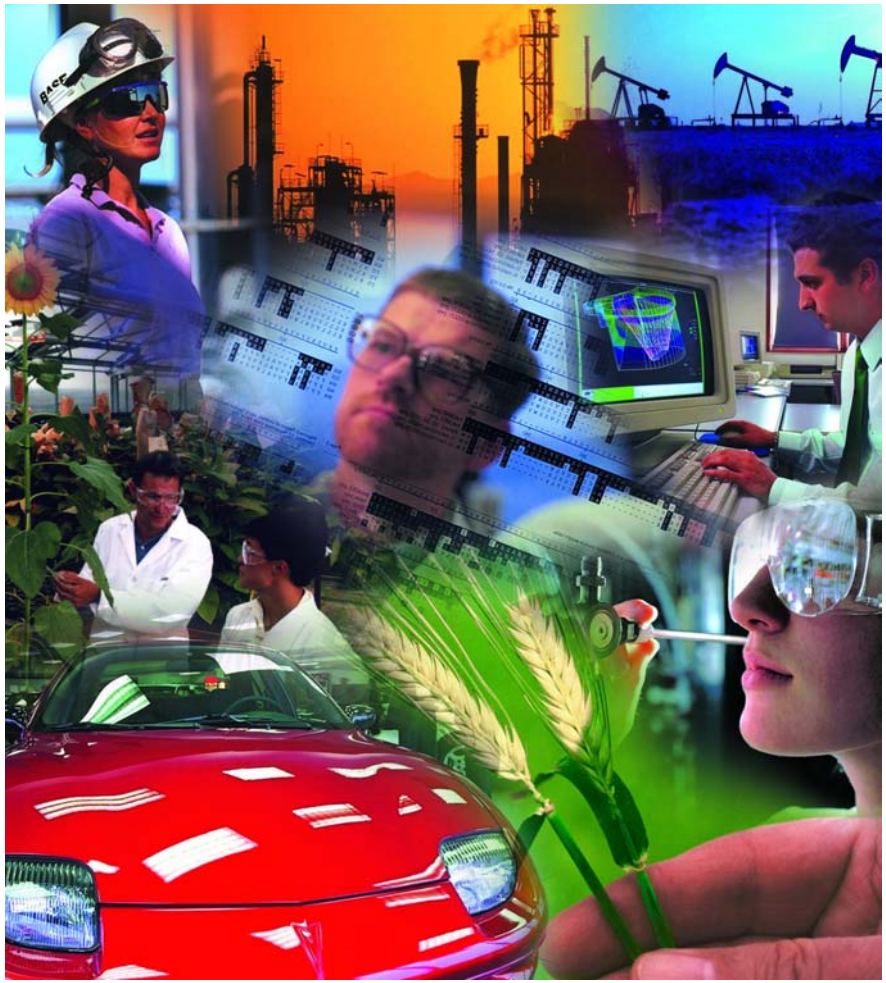
BASF‘ Profile

- The world’s leading chemical company
- Adding value through growth and innovation
- Oriented toward Sustainable Development
- Operating internationally
- Active portfolio management

Ludwigshafen Site

- BASF's first and largest production site worldwide
- More than 8,000 products
- 7.11 km² site
- About 2,000 buildings
- About 115 km of roads
- About 211 km of rail track
- About 2,000 km of above-ground piping

Making Products Better



- BASF's products and services should benefit mankind.
- BASF's products help satisfy people's basic need for food, clothing, shelter, health and mobility, while providing for a better day-to-day standard of living.
- BASF therefore contributes to solving the problems of a growing global population.

BASF's Segments

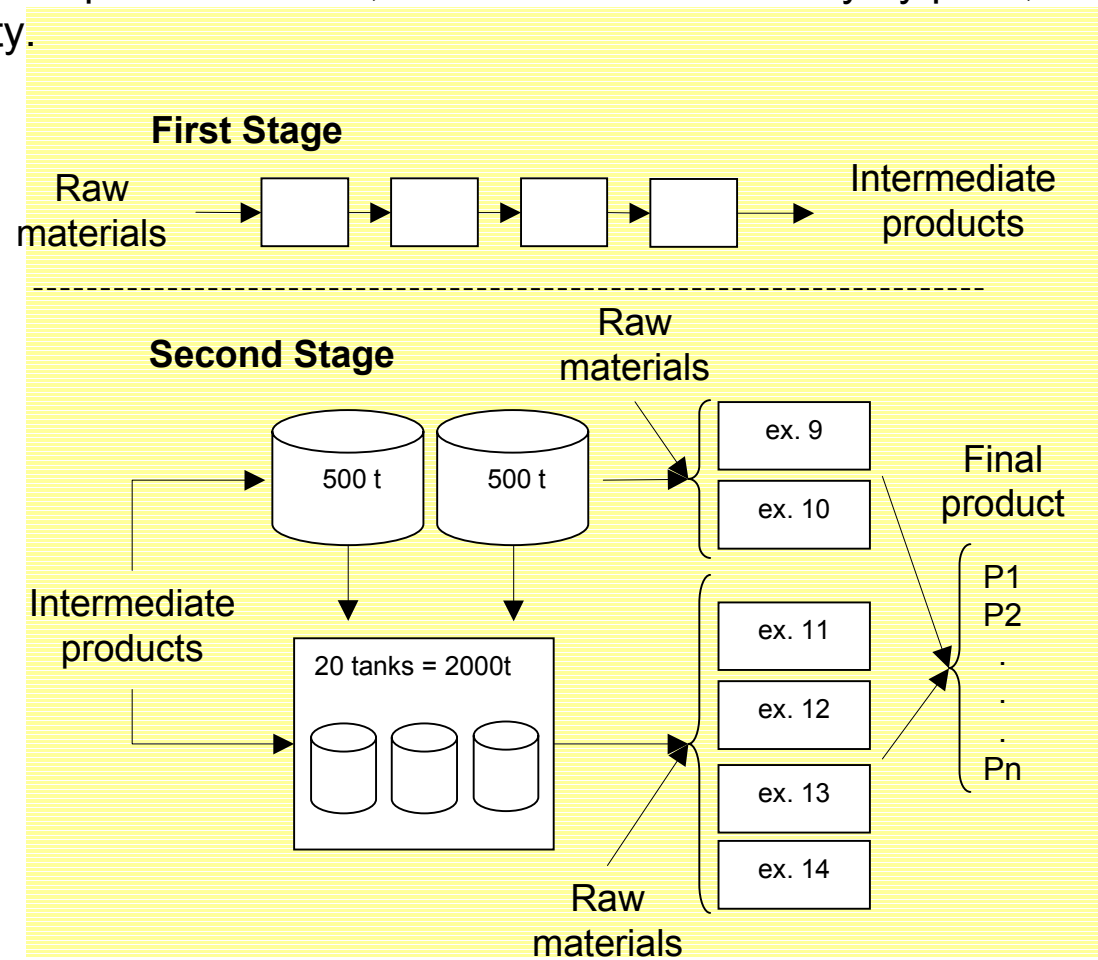
Segments	Products (examples)
Chemicals	Petrochemical feedstocks, plasticizers, electronic grade chemicals, glues and resins, amines, diols, intermediates for paints, fibers and fine chemicals
Plastics & Fibers	Styrene, styrene-based polymers, specialty foams, engineering plastics, polyols, isocyanates, polyurethane systems and polyurethane specialty elastomers, fiber intermediates, nylon-based fibers
Performance Products	Textile and leather chemicals, pigments, raw materials for detergents, gasoline and diesel additives, refinery chemicals, superabsorbents, adhesive raw materials, paper chemicals, construction chemicals, automotive coatings
Agricultural Products	Herbicides, fungicides, insecticides, vitamins, pharmaceutical active ingredients, UV absorbers
Oil & Gas	Crude oil and natural gas (exploration, production and trading)

Case study “BASF 2”: Polypropylene Production

Polypropylenes are mostly “commodities”: competition is keen, customers decide mostly by price, in the second order by service and flexibility.

Manual planning (without optimisation):

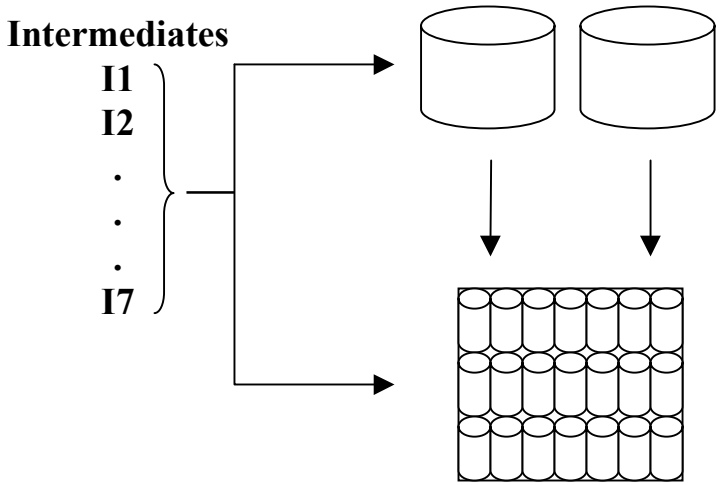
- needed three days
- no chance to consider quality aspects
- low flexibility at the occurence of disturbances
- difficulties to react to short-term demands



Polymerisation Stage

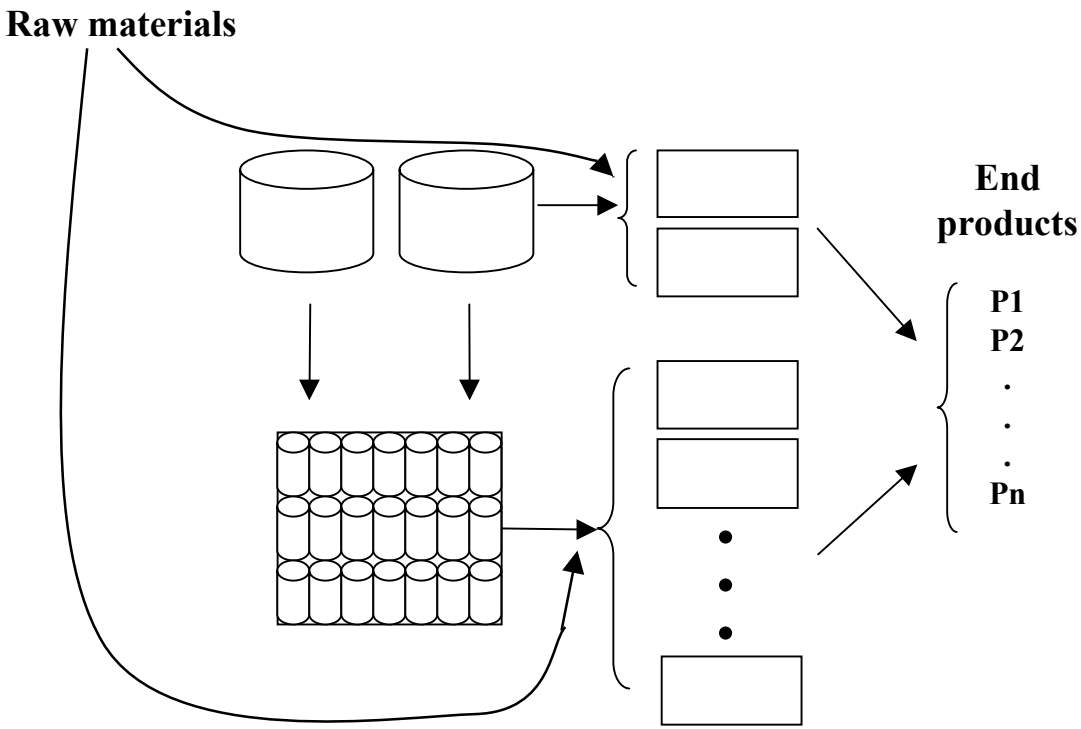
- Continuous production on 24 hours/day
- Campaign production with variable size
- Sequence-dependent changeover times

Intermediate Storage



- Storage of intermediate products before the second stage
- Limited capacity
- Only one product per silo

Extrusion Stage



- Continuous production on 24 hours/day
- Campaign production with variable size
- Production rate depends on product and machine

The Optimisation Problem

Lot-Sizing Problem: Distribute anticipated customer demand for the next three months into campaigns of variable size

Assignment problem: Determine the machine for each campaign

Sequencing problem: Find a valid sequence for each individual machine

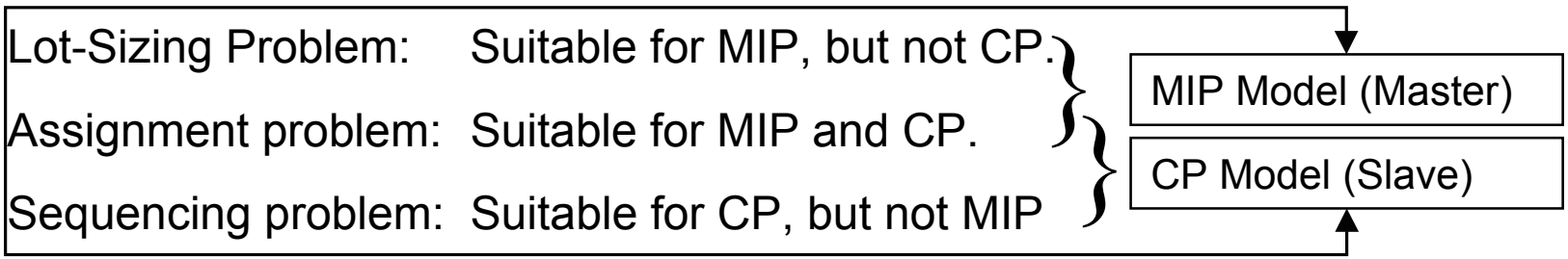
Global objective: Minimize inventory while respecting the customers due dates

We can not

- solve lot-sizing without assignment, because machines are very different in speed
- solve assignment without sequencing, because of strong restrictions on changeovers
- solve sequencing without lot-sizing, because of the limited buffer size for intermediates and complex temporal relationships between campaigns

We have to solve all three problems simultaneously!

The Optimiser‘s Problem



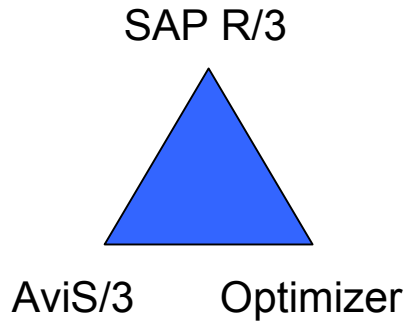
use MIP and CP

We can ~~not solve all three problems~~ simultaneously!

Implementation and Results

Software:

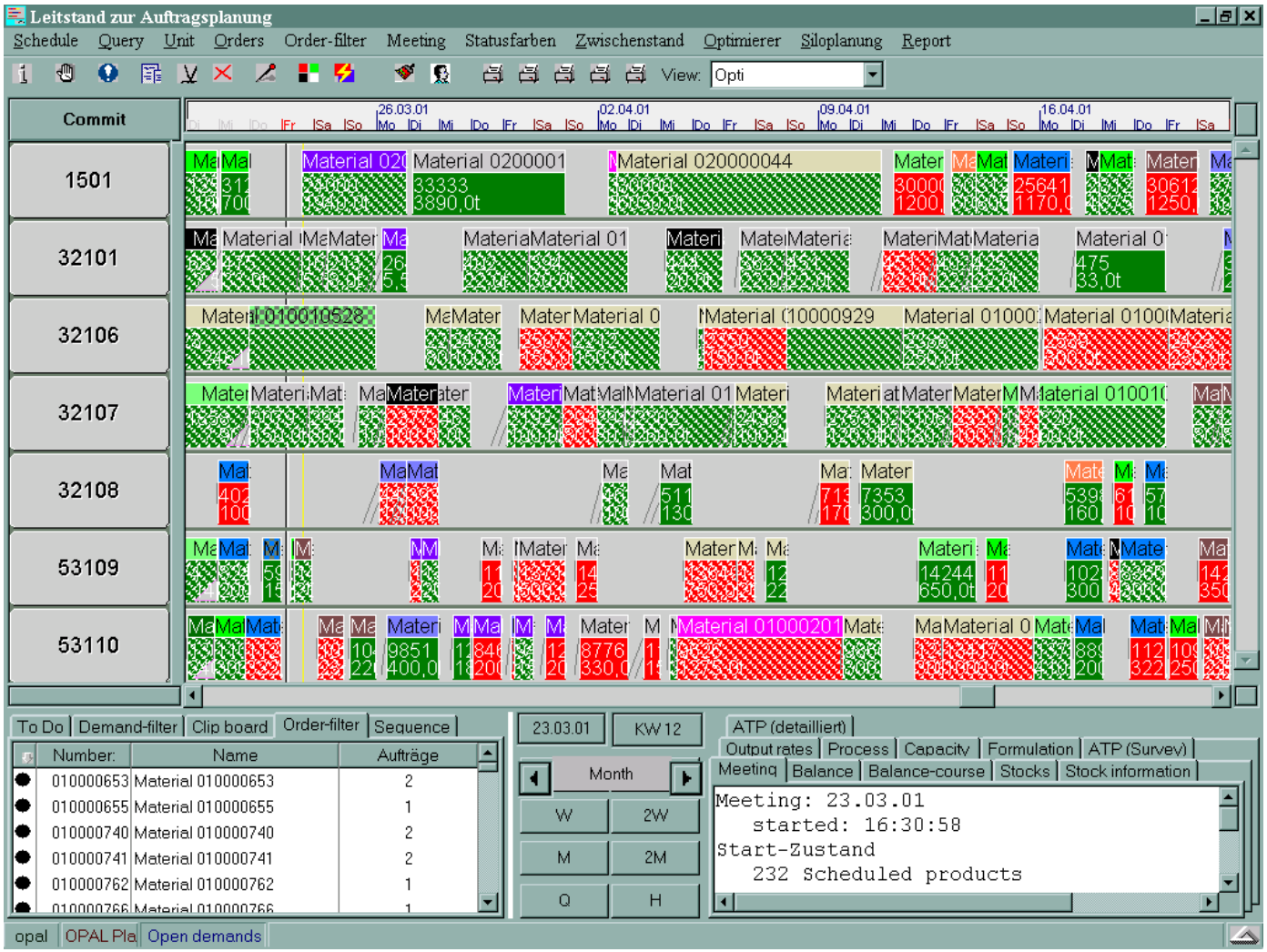
- XPRESS-MP (Dash Optimisation) for MIP
- CHIP (Cosytec) for CP
- Advanced Visual Scheduler (BIS) for Visualisation



Benefits:

- Optimal plan (w.r.t objective function) available in less than 10 minutes
- Total planning process needs a few hours
- Flexibility, Reactivity

Visual Scheduler (AviS/3)



Outlook

Many supply chain optimisation problems in process industry involve the three aspects of lot-sizing, assignment and sequencing

- With the combined MIP/CP algorithm based on Mosel even very complex supply chain planning problems can be formulated and solved with a few hundred lines of code.
- Independent of hardware platforms and software environment
- A second implementation of the combined approach is already being implemented at BASF