

Cyclic planning in a multi-echelon network

**A.Peyraud, E. Jacquet-Lagrèze, R.Rébaï, C.Verlhac,
V. De Vulpillières**

EURODECISION

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1.a) Characteristics

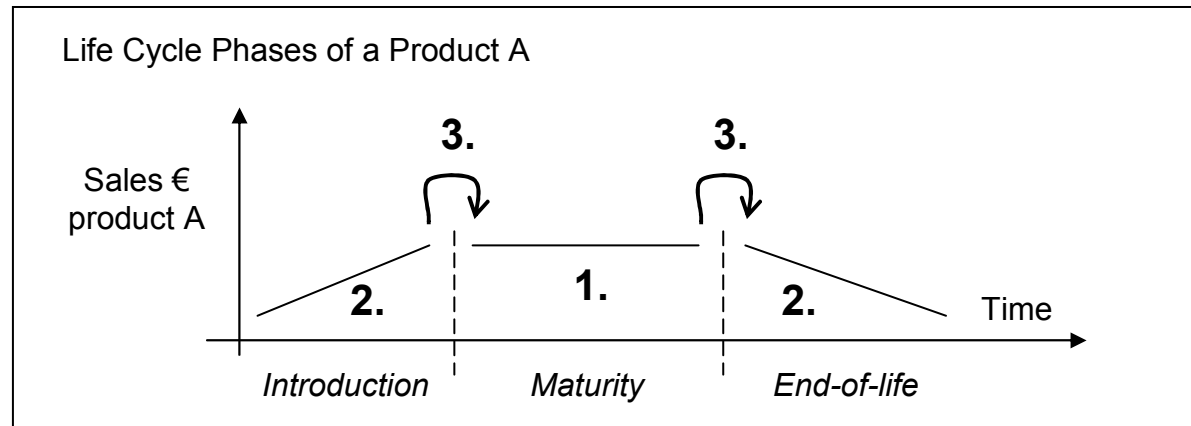
- I. ECLIPS : Extended Collaborative integrated Lifecycle Planning System
- II. Research project in Supply Chain Management
- III. Period : 3 years from Q2'06
- IV. Partners:
 - a) MÖBIUS Be Supply Chain expertise
 - b) Riga Technical University Lv Academic
 - c) EURODECISION Fr Optimization expertise
 - d) LOQUTUS Be Software development
 - e) Huntsman De End User (Chemical)
 - f) Pliva-Lachema Diagnostica Cz End User (Pharmaceutical)
- V. Partially funded by the European Commission in the context of its Research Framework Programme 6



1.b) Research Agenda

I. Extend the State-of-the-Art taking into account

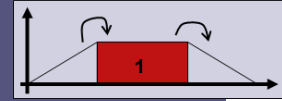
- a) The Multi-Echelon, optimization of a supply chain
- b) The different phases of a product lifecycle and their integration



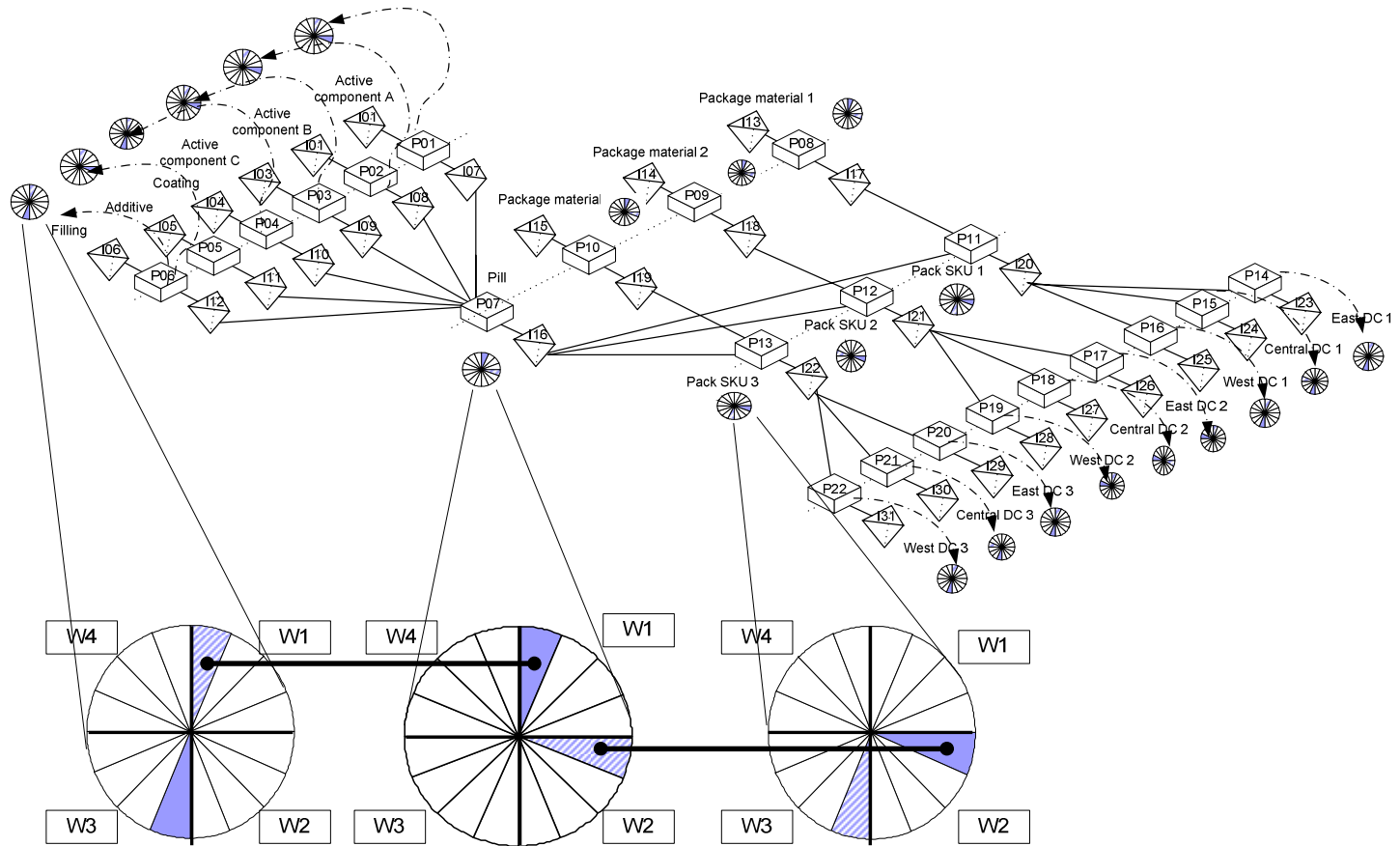
II. 3 Key Research Topics

- a) Maturity phase : Multi-Echelon Cyclic Planning
- b) Introduction / End-of-life : Improved Statistical Forecasting
- c) Lifecycle Integration : Automated switching of Supply Chain Control

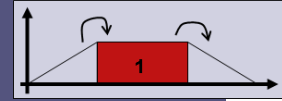
2.a) Multi echelon cyclic planning



- I. Find cyclic schedules for long term planning at every echelon.
- II. Example: 3 processes, Synchronized every 4 weeks.

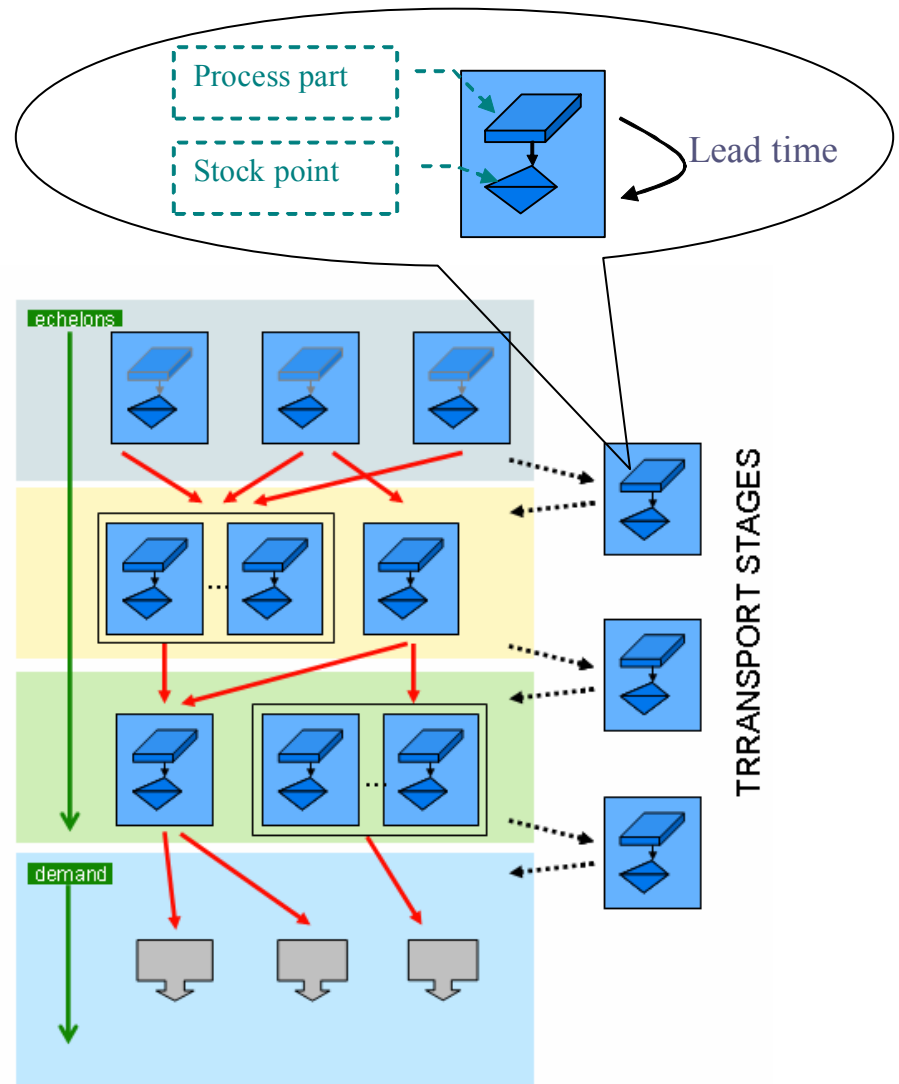
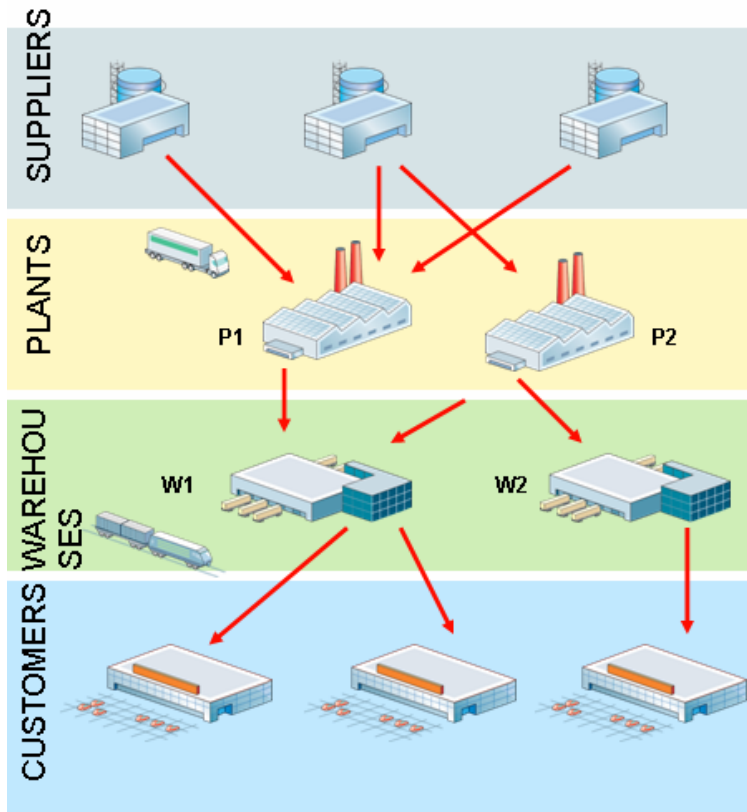


2.b) Network

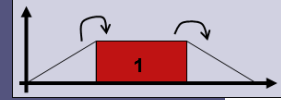


Network is a user input

Unlimited number of echelons, stages (processes)...

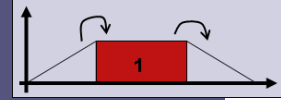


3.a) Data



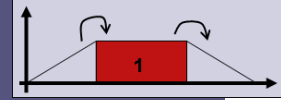
- I. Network
- II. BOM (Bill of material)
- III. Demand
- IV. Capacities (min/max for production and storage)
- V. Costs

3.b) Variables



- I. **Production quantity** for each stage and time step
- II. **Storage level** for each stage, product and time step
- III. **Flow of product** provided by one stage to another stage or customer at a given time step
- IV. **Status of the process** (switched on/off) for each time step
- V. **Cycle** for each stage (selected with binary variables)

3.c) Constraints



- I. Inventory, production and flows balance constraint** for each stage, product and time step
 - the new production once the lead time is passed +
 - the stock at previous period (or initial stock) =
 - the new stock +
 - quantities provided by current stage to following stages +
 - quantities provided by current stage to customers

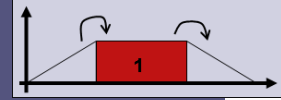
- II. Input product constraint (BOM)**

- III. Demand constraint** for each customer, product and time step

- IV. Production capacity constraints** by stage and time step

- V. Storage capacity constraints** by product, stage and time step

3.c) Constraints



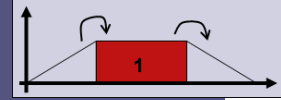
VI. Cyclic constraints

- A single cycle has to be selected by stage
- The production process is switched on once during each cycle for each stage
- The first production can happen at any moment during the cycle length

VII. Optional (shared capacity)

- Storage capacity constraints by stage and time step
- Storage capacity constraints by group of stages and time step
- Production capacity constraints by group of stages and time step

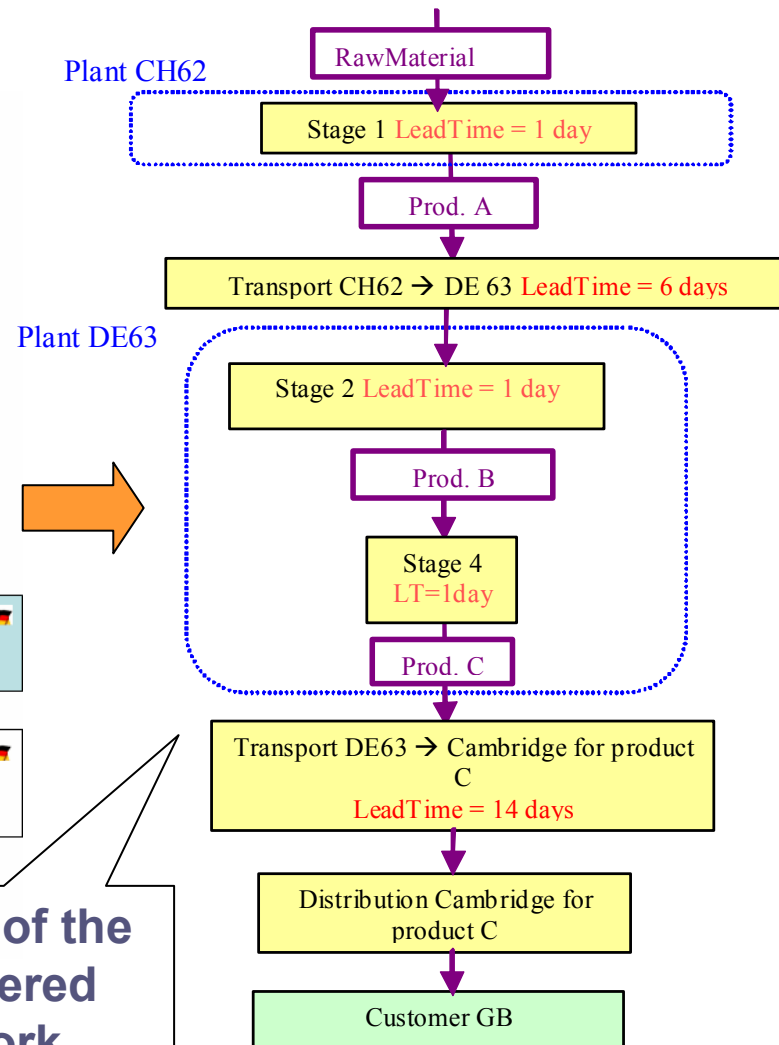
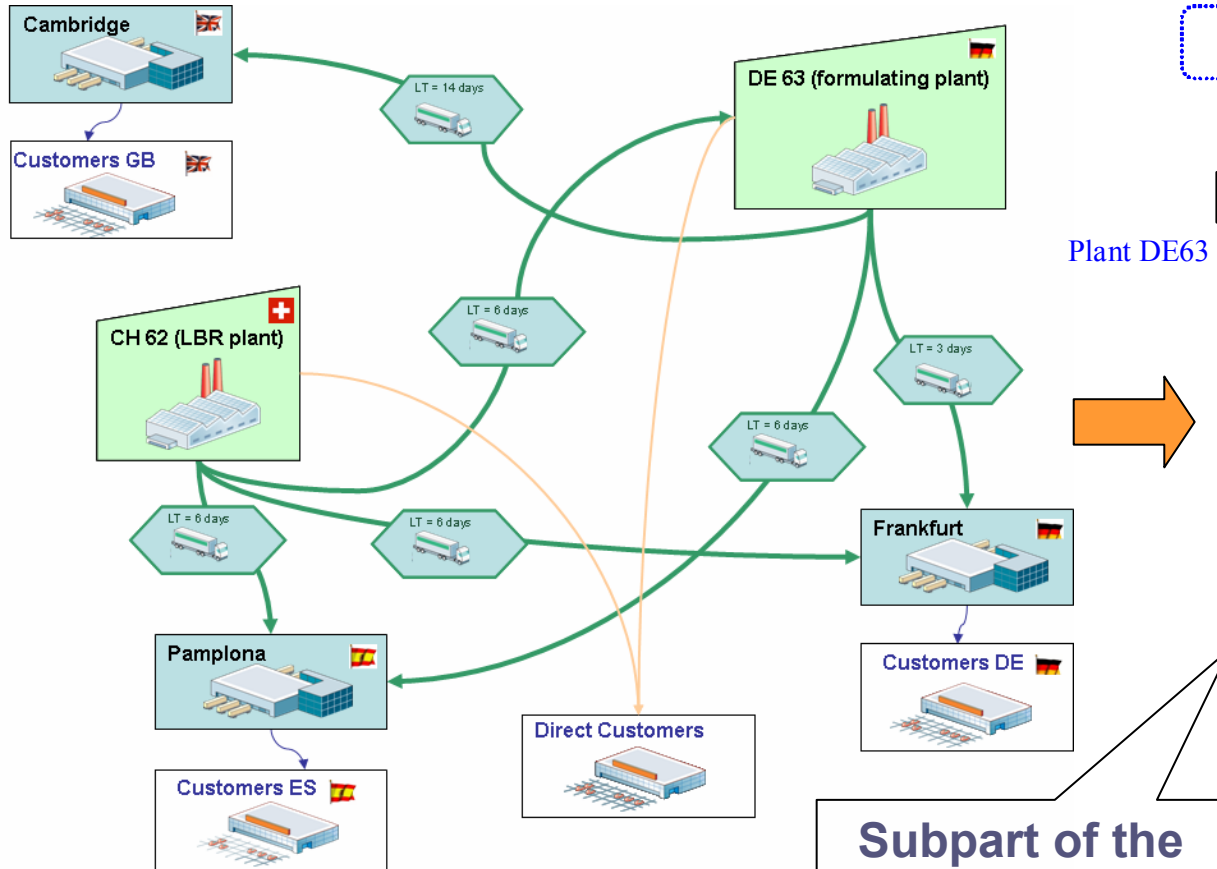
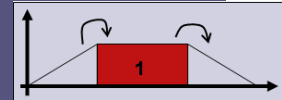
3.d) Economic function



MINIMIZE

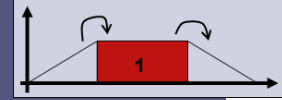
- a) **Production costs**
Linear cost (€ / unit of product)
- b) **Setup costs**
Fixed cost (€)
- c) **Holding costs**
Linear cost (€ / unit of product)

4.a) Huntsman network



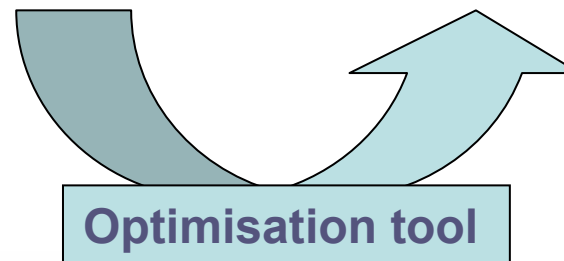
Subpart of the considered network

4.b) Inputs and outputs

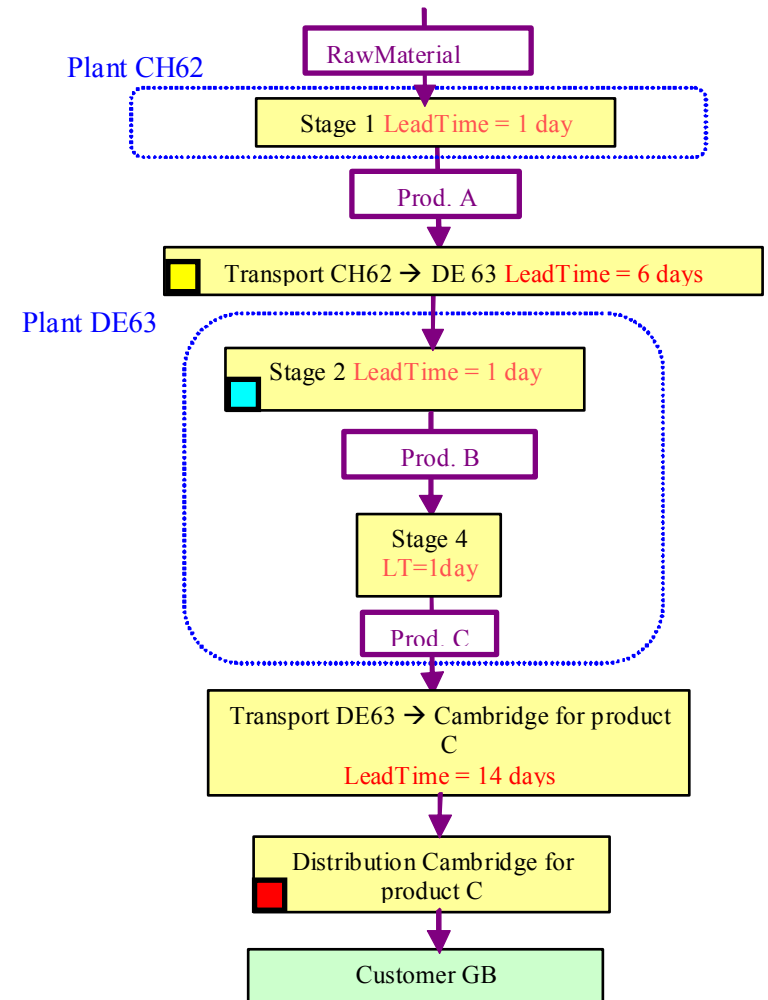
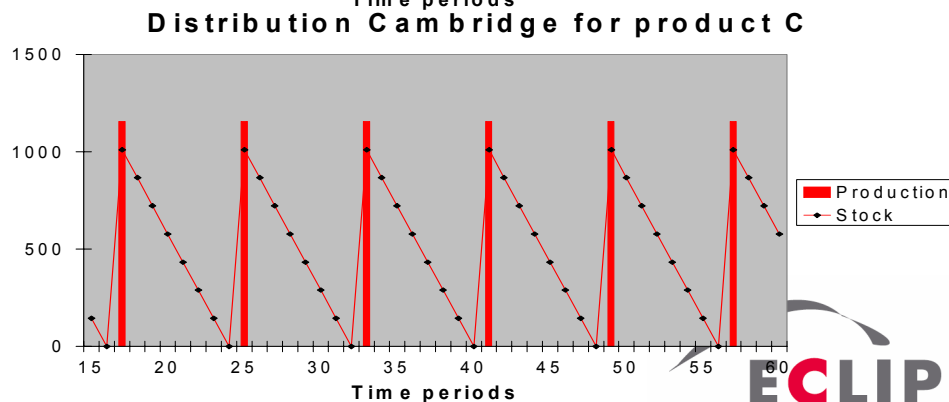
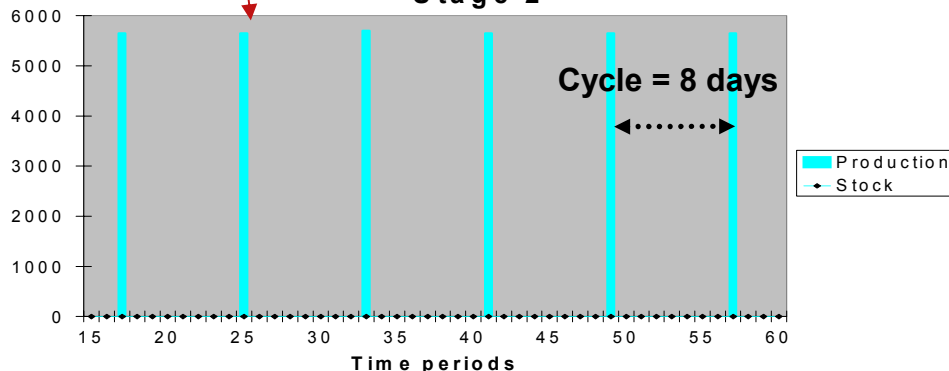
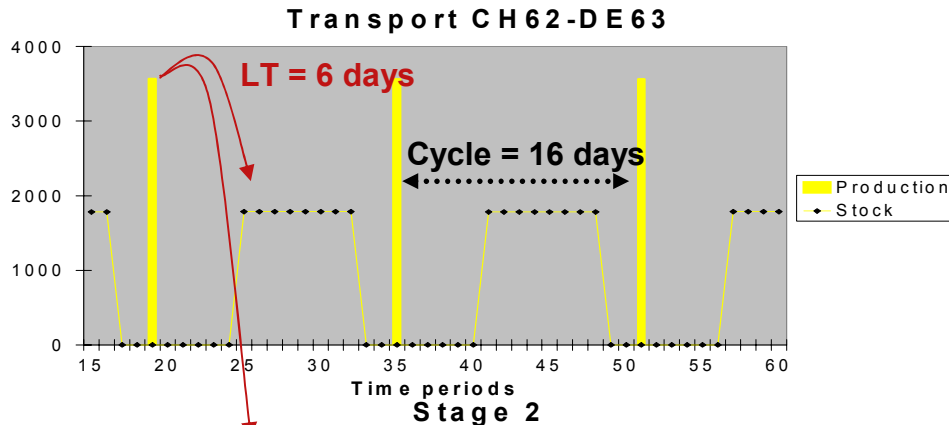
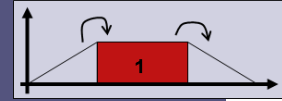


Inputs	Value
Network	1 products family
Granularity	Day
Planning horizon	90 days
Demand per period	Average of global demand
Costs : setup, holding, production	Assumed
Capacity limits	None

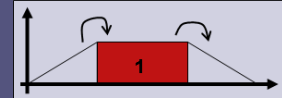
Outputs
Production quantity per stage and period
Stock level per product and period
Cycle per stage



4.c) Production cyclic planning



4.d) Complexity



I. Number of variables: 191 079

Binary variables = 5049

II. Number of constraints: 238 970

➤ Big M constraints ($X \leq M.B$): 4590

➤ Cyclic constraints: 5150

=> First decomposition strategy

Optimisation time: 2014 sec (Ilog CPLEX)

Gap = 0.01

=> *Further research to follow...*

Any question?

