
Optimization Based Approach for Managing Enterprise-Wide Business Planning in a Petrochemical Industry

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Outline

Ø Planning problem in petrochemical industry

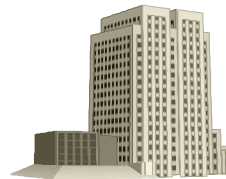
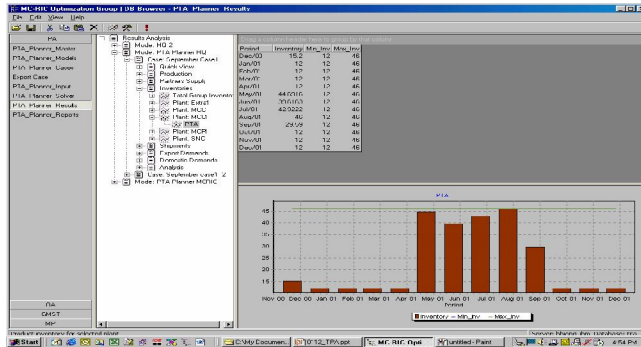
Ø Business planning decisions/ issues

Ø Planning application requirements

Ø Example

Ø Summary

Supply Chain Planning Problem



- Environment for:**
- data access
 - decision supports:
 - strategic planning
 - production planning
 - logistics
 - business performance analysis

How to make the most profitable decisions?



How to reduce cost?

How to improve productivity?

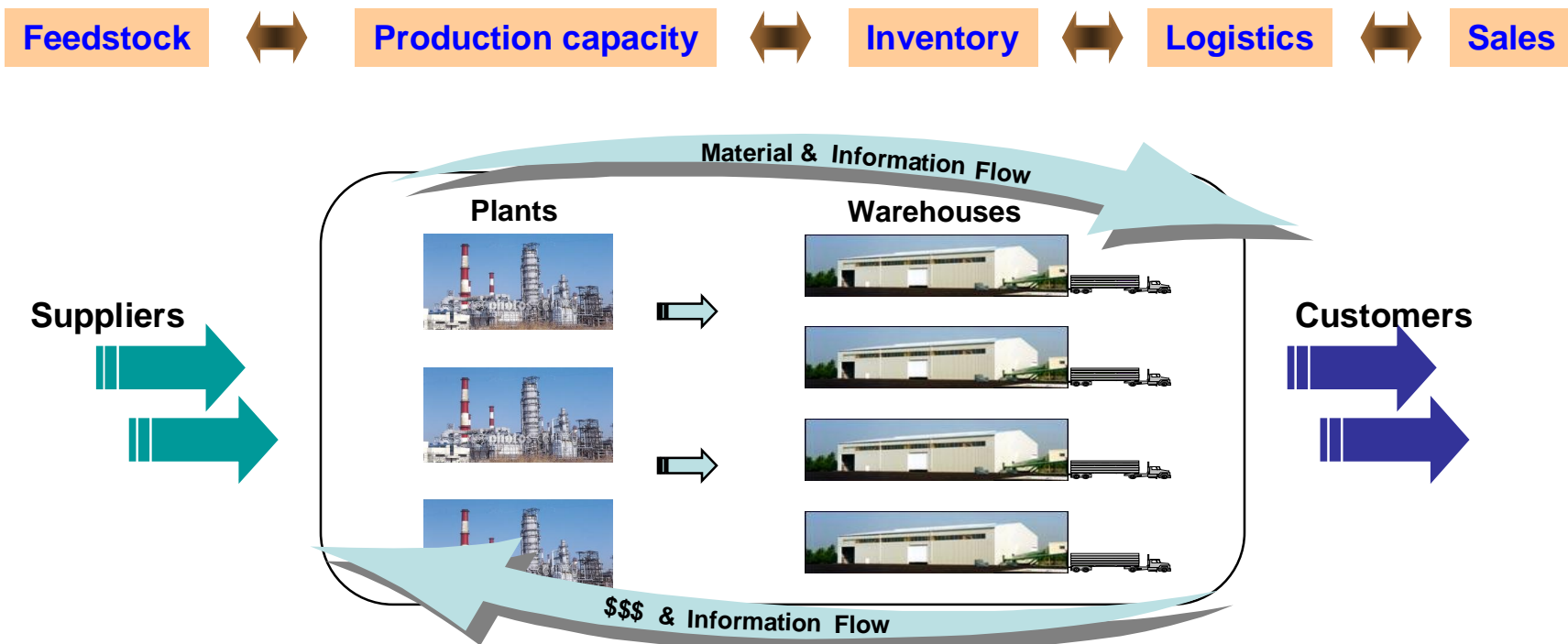
How to improve business?



Horizontal Decision Complexity

Ø Horizontal interactions in supply chain decisions

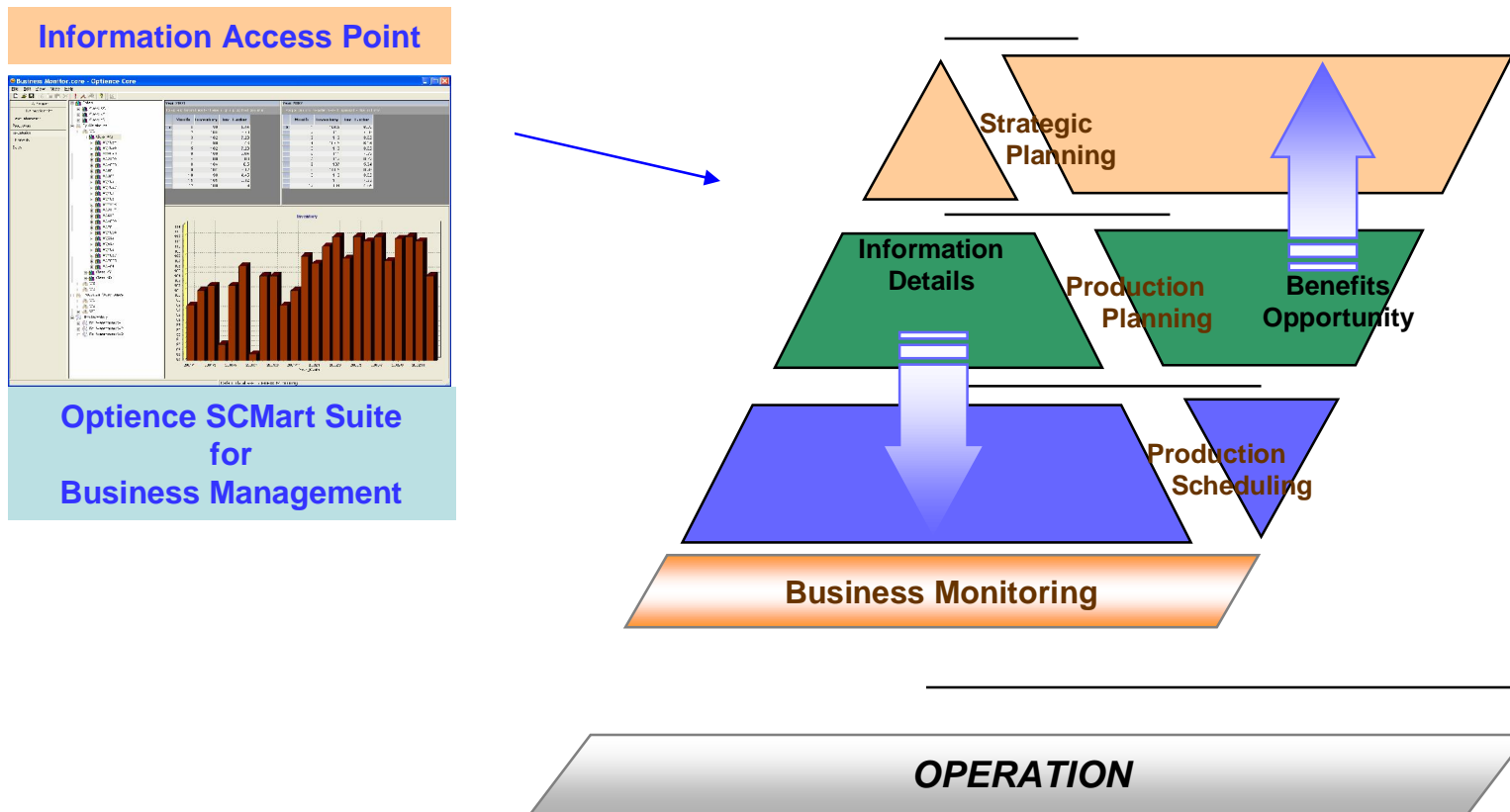
- » Flexibility of operation options
- » Function of time



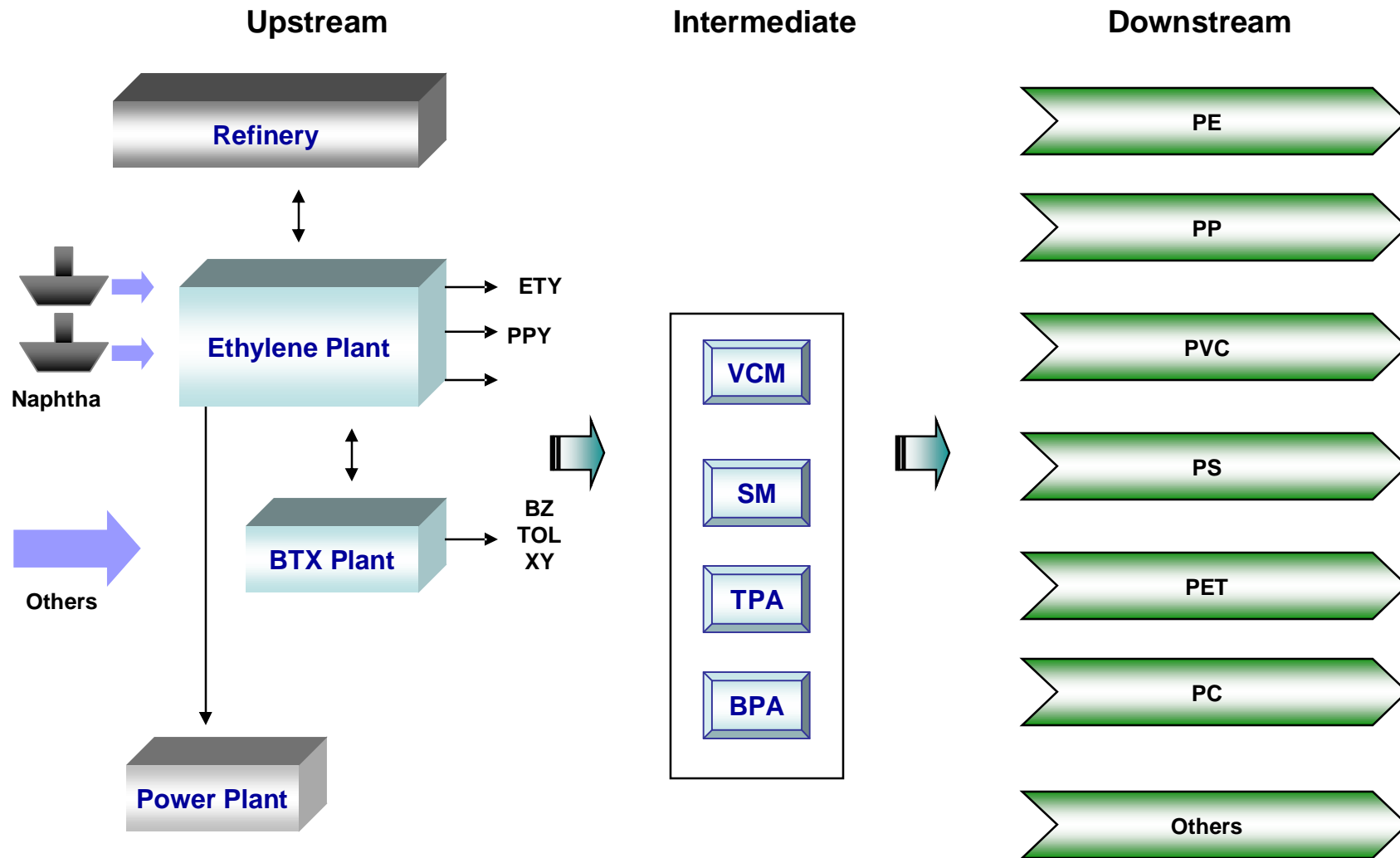
Vertical Decision Complexity

∅ Vertical interactions in supply chain decisions

» Consistency – Planning, Scheduling & Real Operation

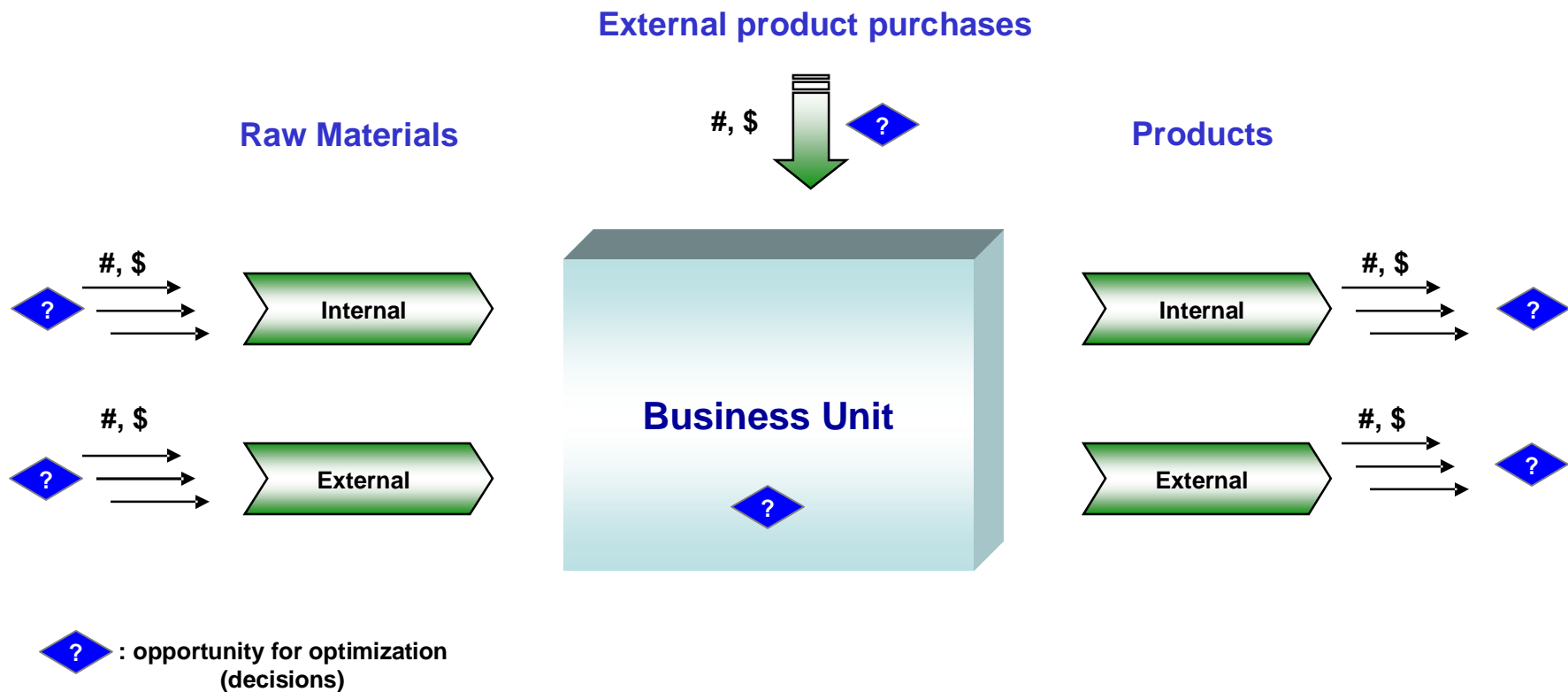


Integrated Petrochemical Business

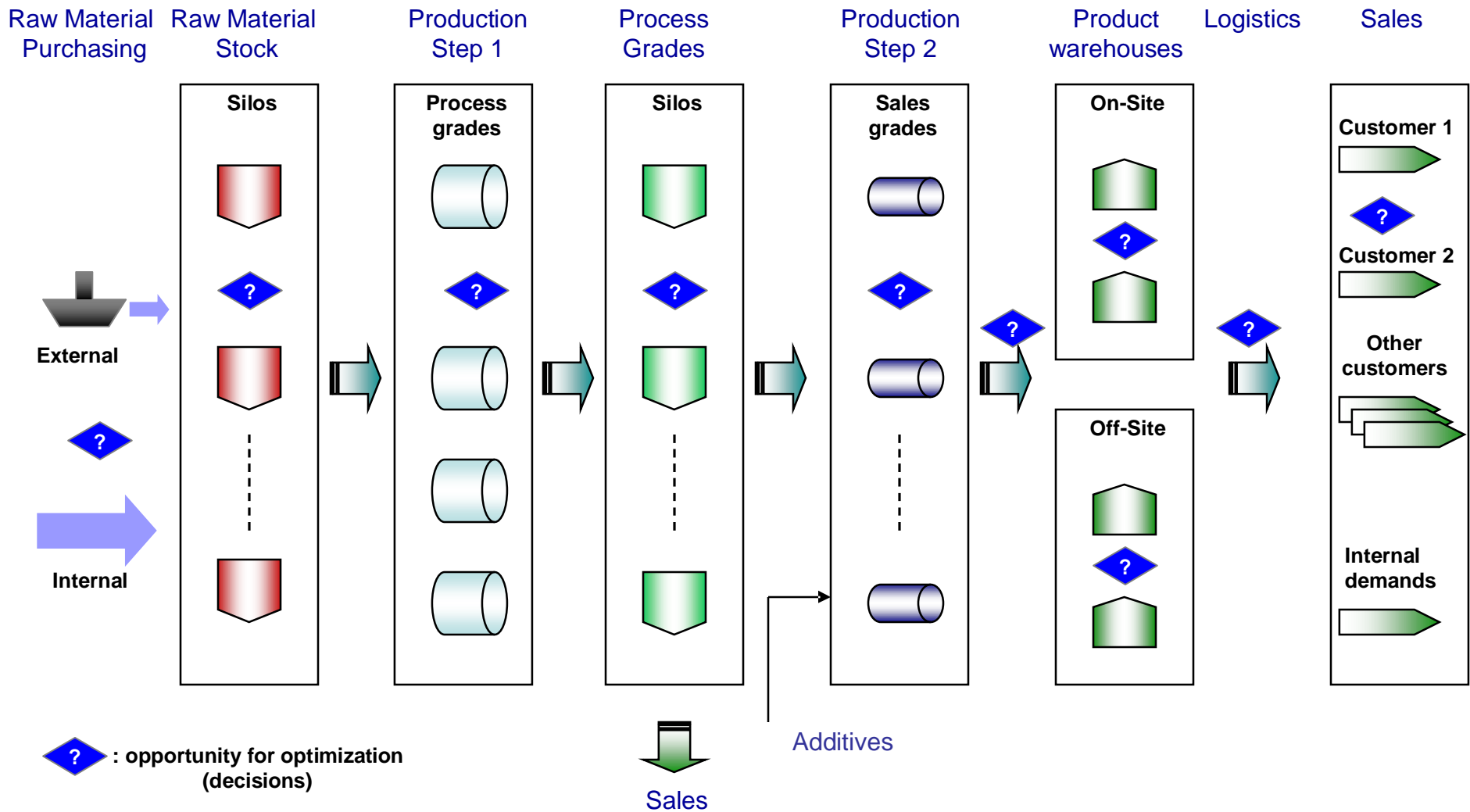


Upstream/ Intermediate Business

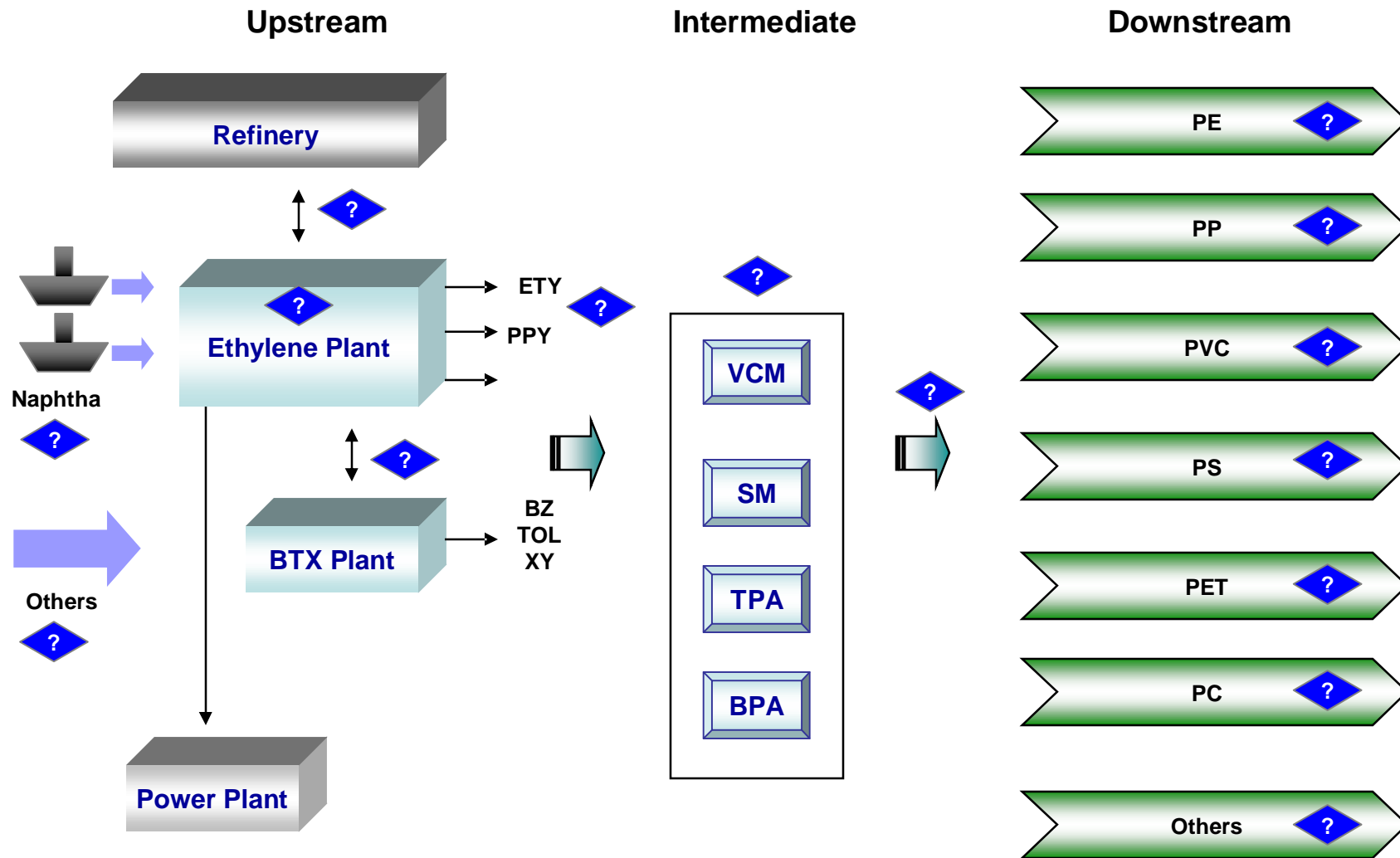
Ø Supply chain planning decision at each business unit



Downstream Business



Planning for Integrated Petrochemical Business



Challenges in the integrated Planning Problem

∅ Problem characteristics

- Upstream/intermediate processes

- Operation

- » Continuous
- » Few products - co-productions
- » Simpler product distributions

- Challenges

- » Non-linear – Blending/mixing, Yield performance
- » Combinatorial – Operational constraints

- Downstream processes

- Operation

- » Continuous/ batch
- » Many products – Product recipes/ Product allocations

- Challenges

- » Complex resource allocation, product inventory and distribution management

Business Planning Decisions (1/3)

Ø Raw material purchasing

- » What material, How much, From which supplier & When?
 - Need to consider
 - » Prices, logistics, inventory level, business policy

Ø Raw material storage

- » Storage management – today & future operation plan
 - Need to consider
 - » Allocation for new arrival and feeding to production lines/plants
 - » Manage inventory level for all storages

Ø Production

- » What to make, How much, Which plant & When?
 - Need to consider
 - » Availability & capacity of plants, production efficiency
 - » Product inventory & demands

Business Planning Decisions (2/3)

∅ Product storage/ warehouses

- » What product, how much to keep, where?
 - Need to consider
 - » Demands, productions, logistics

∅ Logistics

- » Logistic cost management – today & future operation plan
 - Need to consider
 - » Demands, Inventory at each warehouse, production

∅ Sales

- » What product, how much, prices, where & when?
 - Need to consider
 - » Production & inventory
 - » Logistics cost, business policy

Business Planning Decisions (3/3)

All of the above decisions are related &
have impacts on overall profit

Need to consider the trade-off of key decisions
simultaneously

Issues in Planning Problem

Ø Understanding the impacts of uncertainty

- » Price changes
- » Demand changes
- » Capacity changes
- » Business policies
 - Inventory
 - Product allocation

Ø Require sensitivity analysis

- » Create case & sub-cases
 - Impact of changes on profitability

How do we make a decision
for
Enterprise Wide Business Planning?

Need an optimization based application?
What kind?

Planning Application Requirements (1/2)

∅ Problem representation/ Modeling capability

- Problem scope
 - Modeling of upstream to downstream businesses
 - » In the same environment as one model
- Modeling approach
 - Concise problem representation
 - » Unit operation based approach
 - » Automatic mathematical model generation – data driven
 - Multi-level modeling
 - » Support multi-level model aggregation – different applications
- Modeling capability
 - Mathematical programming approach
 - » Model for linear, nonlinear & combinatorial problem (LP, NLP, MILP & MINLP)
 - » Robust optimization solution engines

Planning Application Requirements (2/2)

∅ Data/ model management

- Data I/O
 - Efficient data transfer/ viewing
 - » Open database architecture
- Data viewing/ analysis
 - Efficient environment for data viewing & analysis
 - » Rapid UI development environment

∅ Supporting workflow

- Model/data – communication & sharing
 - Multi-level application
 - » Planning & Scheduling
 - Cross-department
 - » Purchasing, Planning, Sales, etc..

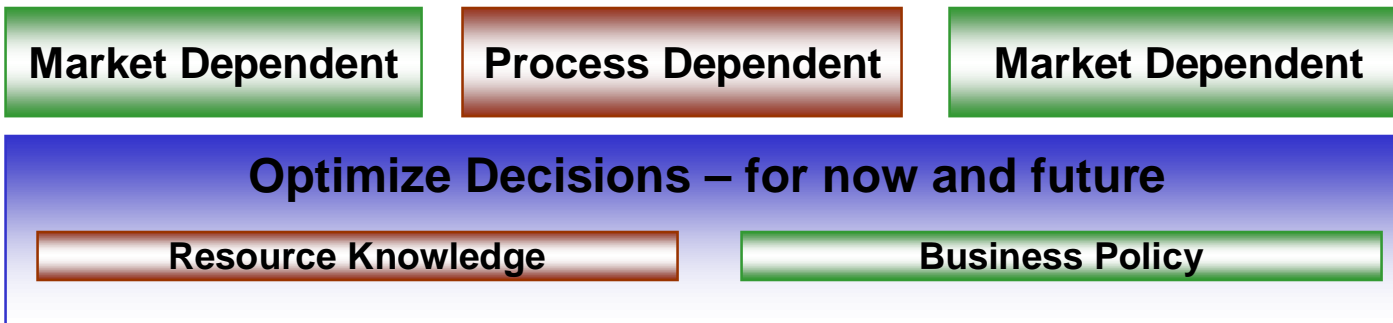
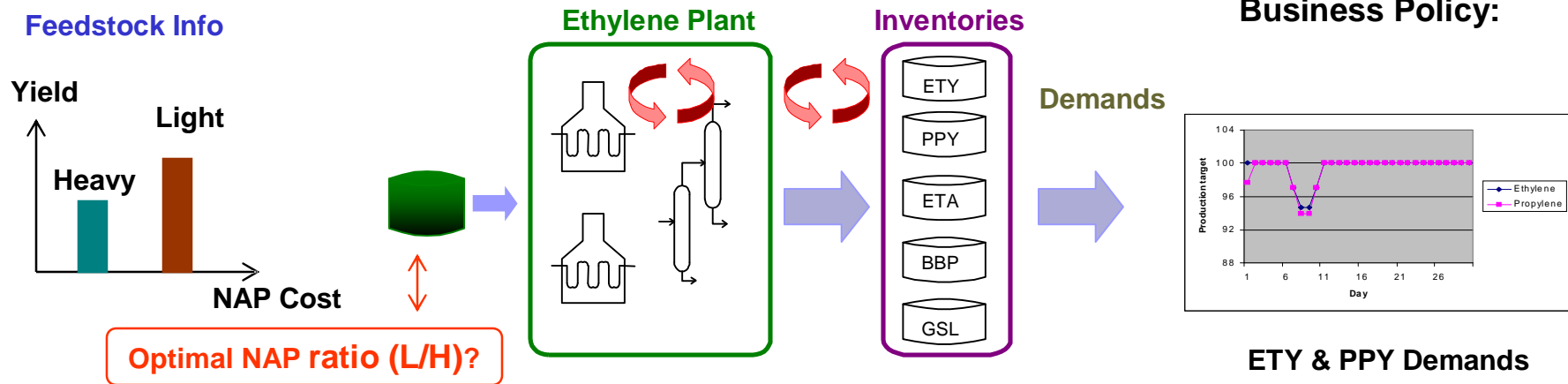
Example of Applications

Ethylene Business Planning & Scheduling

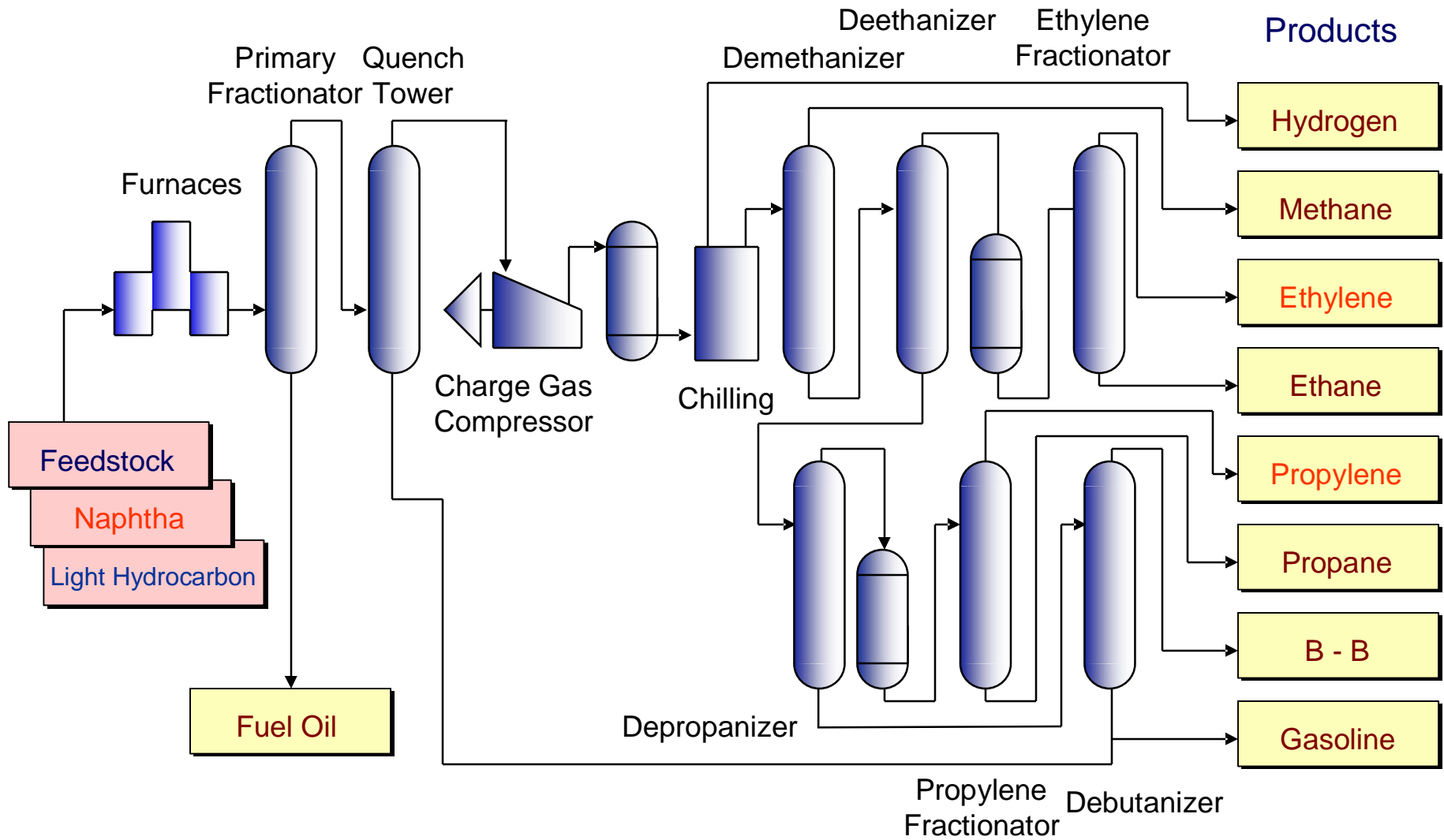


Ethylene Business Optimization Opportunity

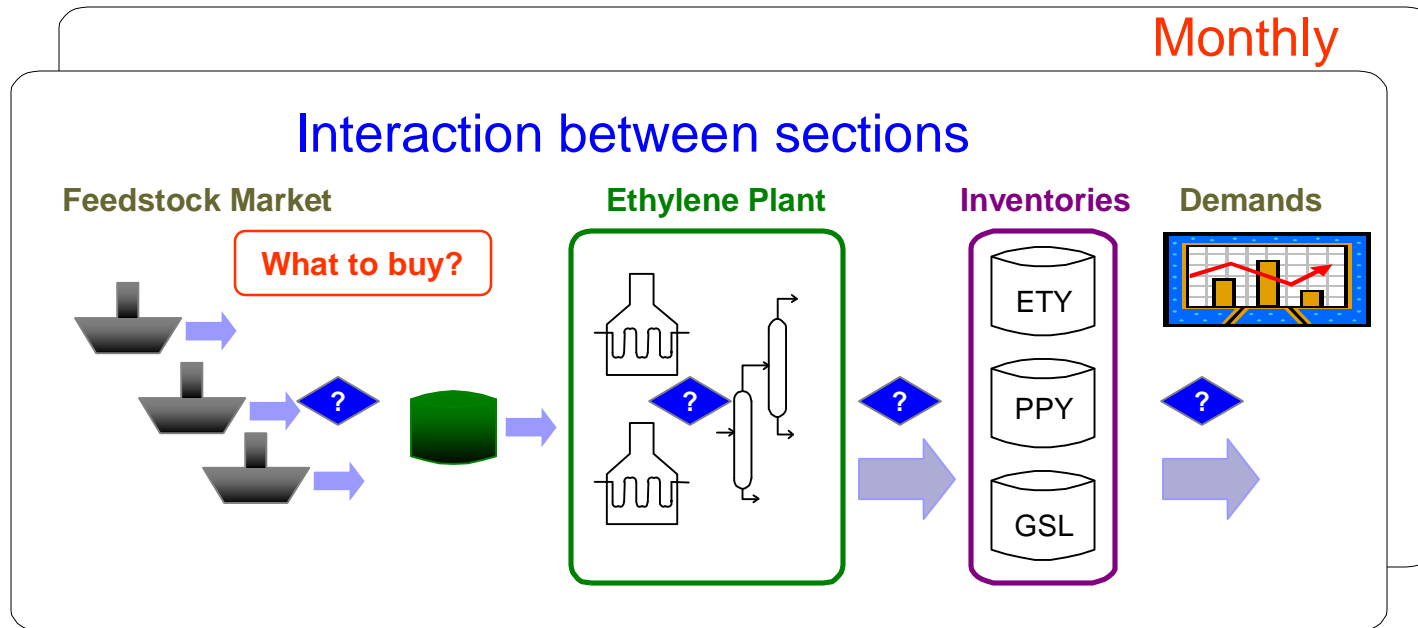
A Business Scenario



Ethylene Plant – Process Flow Diagram



Optimization - Ethylene Business Planning



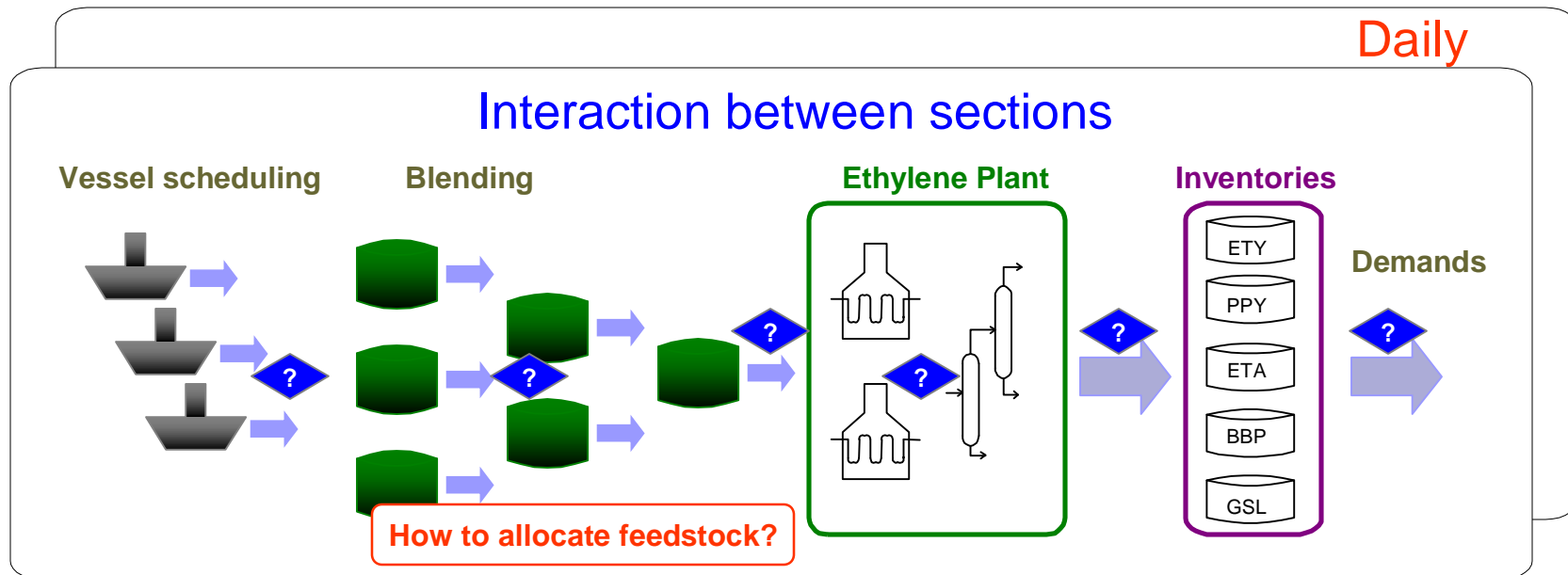
Planning:

- Aggregate model
- Business policy analysis

Main Focus:

Find optimal feedstock purchases for production planning,
for meeting production demands

Optimization - Ethylene Production Scheduling



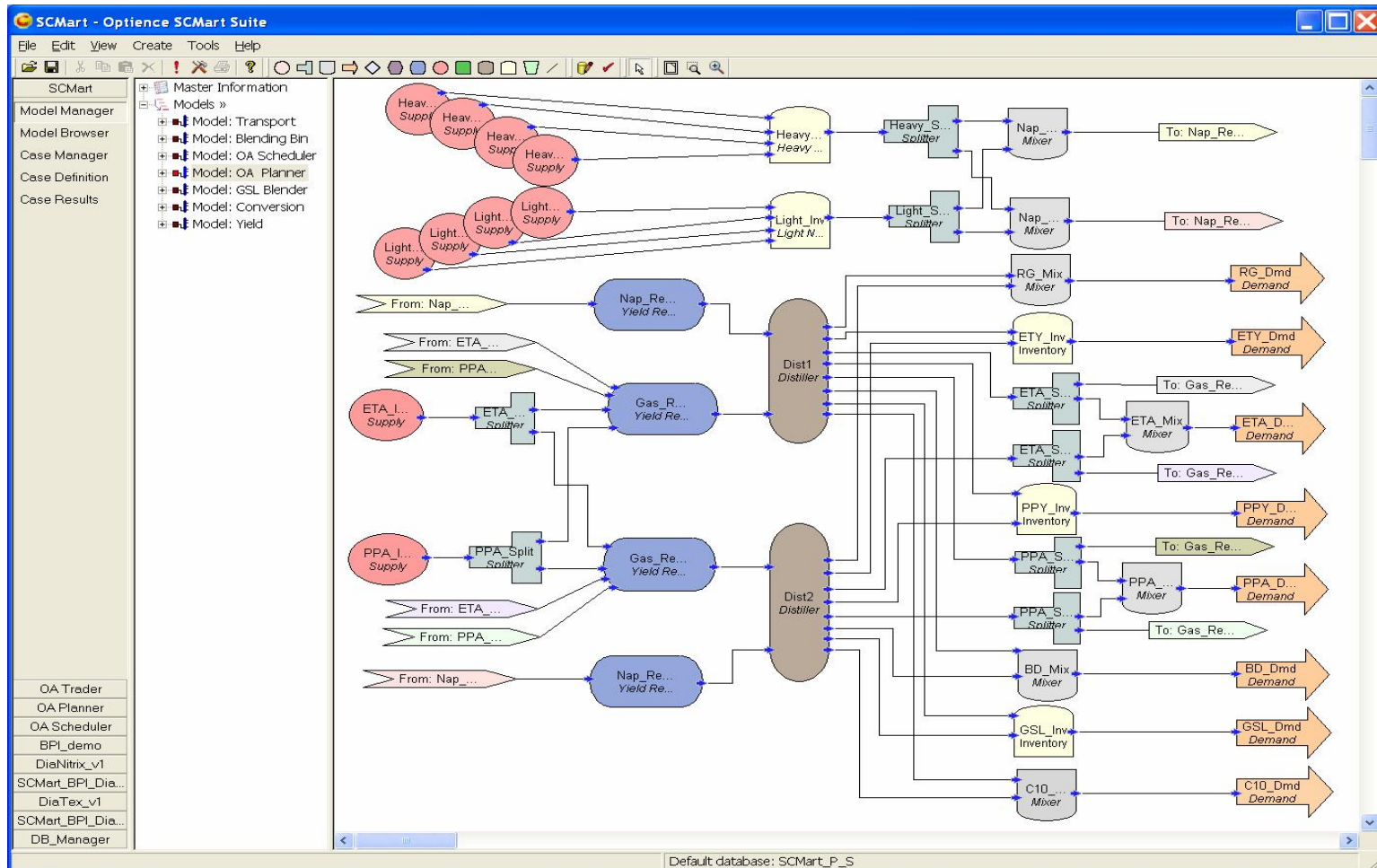
Scheduling:

- Accurate (rigorous) daily production model
- Mixed Integer Nonlinear optimizer

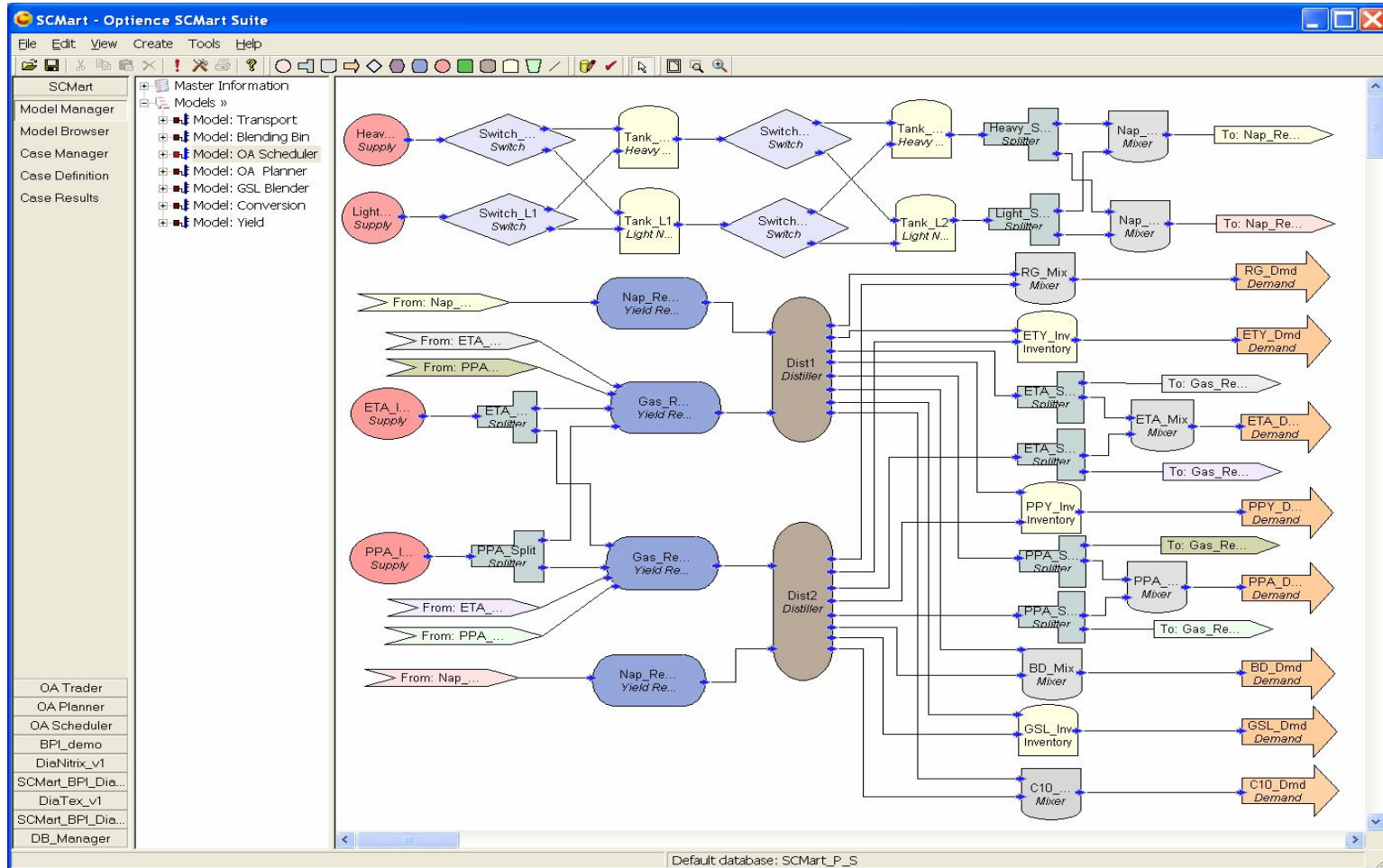
Main Focus:

Find optimal feedstock allocation for daily production scheduling,
for meeting production demands

Model Representation – Planning



Model Representation – Scheduling



Planning Application

Ø Planning result – summary

The screenshot displays the 'OA Planner - Optience SCart Suite' application. The left-hand pane shows a project tree with 'Case: JanMar_Base' selected. The main window is divided into three sections:

- Economics:** A table showing key financial metrics.

Description	MMUSD
Feedstock Cost	187.34
Profit	81.65
Revenue	269
- Production:** A detailed table showing production volumes and percentages for various products across three months.

Month	Product	Production	Percent
Month : 1			
1	BD	24993	9.22
1	C10	9208	3.4
1	ETA	5435	2.01
1	ETY	87192	32.18
1	GSL	60098	22.18
1	PPA	0	0
1	PPY	40000	14.76
1	RG	44023	16.25
Month : 2			
2	BD	22706	9.19
2	C10	8417	3.41
2	ETA	4980	2.02
2	ETY	79041	31.99
2	GSL	53946	21.83
2	PPA	0	0
2	PPY	36000	14.57
2	RG	42006	17
Month : 3			
3	BD	25906	9.05
3	C10	10360	3.62
3	ETA	14600	5.1
3	ETY	82767	28.93
3	GSL	64070	22.39
3	PPA	0	0
3	PPY	43000	15.03
3	RG	45405	15.87
- Naphtha Consumed:** A summary table showing naphtha consumption over three months.

Month	Naphtha_Consumed
1	226300
2	204400
3	226300
- Gas Consumed:** A summary table showing gas consumption over three months.

Month	Gas_Consumed
1	44649
2	42696
3	59808

The status bar at the bottom indicates 'Default database: SCart_v0'.

Planning Application

Ø Feedstock purchasing & planning workflow

The screenshot displays the 'OA Planner - Optience SCart Suite' application window. The interface is divided into several sections:

- Left Panel (Navigation):** Contains a tree view with categories like 'SCart', 'Model Manager', and 'Analysis'. Under 'Analysis', 'Information for Trader' is selected.
- Recommended Purchases Table:** A table showing purchase recommendations for two months.

Month	Naphtha	Available	Selected	SG	Price	Contract	Recommended	Confirm	Notes
Month : 1									
1	Heavy_1	40000	0	0.72	242	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
1	Heavy_2	35000	35000	0.71	237	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
1	Heavy_3	20000	0	0.705	245	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
1	Heavy_4	75000	75000	0.695	242	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
1	Light_1	35000	35000	0.661	255	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
1	Light_2	100000	100000	0.672	247	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
1	Light_3	40000	40000	0.675	250	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
1	Light_4	40000	0	0.685	261	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Month : 2									
2	Heavy_1	45000	0	0.718	240	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
2	Heavy_2	25000	0	0.713	241	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
2	Heavy_3	35000	0	0.698	245	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
2	Heavy_4	70000	70000	0.692	242	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
2	Light_1	20000	0	0.662	260	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
2	Light_2	50000	50000	0.674	247	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
2	Light_3	45000	10500	0.678	250	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
- Target Purchase Volumes Table:** A table showing target purchase volumes for three months.

Month	Concept	Value	Notes
Month : 1			
1	Light Naphtha	175000	
1	Heavy Naphtha	110000	
1	Total	285000	
Month : 2			
2	Light Naphtha	60500	
2	Heavy Naphtha	70000	
2	Total	130500	
Month : 3			
3	Light Naphtha	100000	
3	Heavy Naphtha	115000	
3	Total	215000	

The status bar at the bottom indicates 'Default database: SCart_v0'.

Scheduling Application

Ø Scheduling result – summary

The screenshot displays the 'OA Scheduler - Optience SCart Suite' application. The interface is divided into several sections:

- Left Panel:** A navigation tree showing 'SCart' with sub-items like 'OA_Multi_Demo', 'OA Trader', 'OA Planner', and 'OA Scheduler'. Below this are 'Model Manager', 'Set Problem', and 'Analysis'. At the bottom, there are project names: 'BPI_demo', 'SCart_BPI_DiaNitrix', 'SCart_BPI_DiaTex', 'REX_Library', 'REX_Projects', and 'DB_Manager'.
- Case List:** A list of cases including 'Case: Jan', 'Case: Copy Jan', and 'Case: Example Transfer'.
- Economics Panel:** A table with columns 'Description' and 'MMUSD'.

Description	MMUSD
Feedstock Cost	82.28
Profit	-10.22
Revenue	88.72
- Naphtha Consumed Panel:** A table with one row:

Naphtha_Consumed
226300
- Gas Consumed Panel:** A table with one row:

Gas_Consumed
46148
- Production Panel:** A table with columns 'Product', 'Schedule_Production', 'Schedule_Percent', 'Plan_Production', 'Plan_Percent', and 'Percent_Difference'.

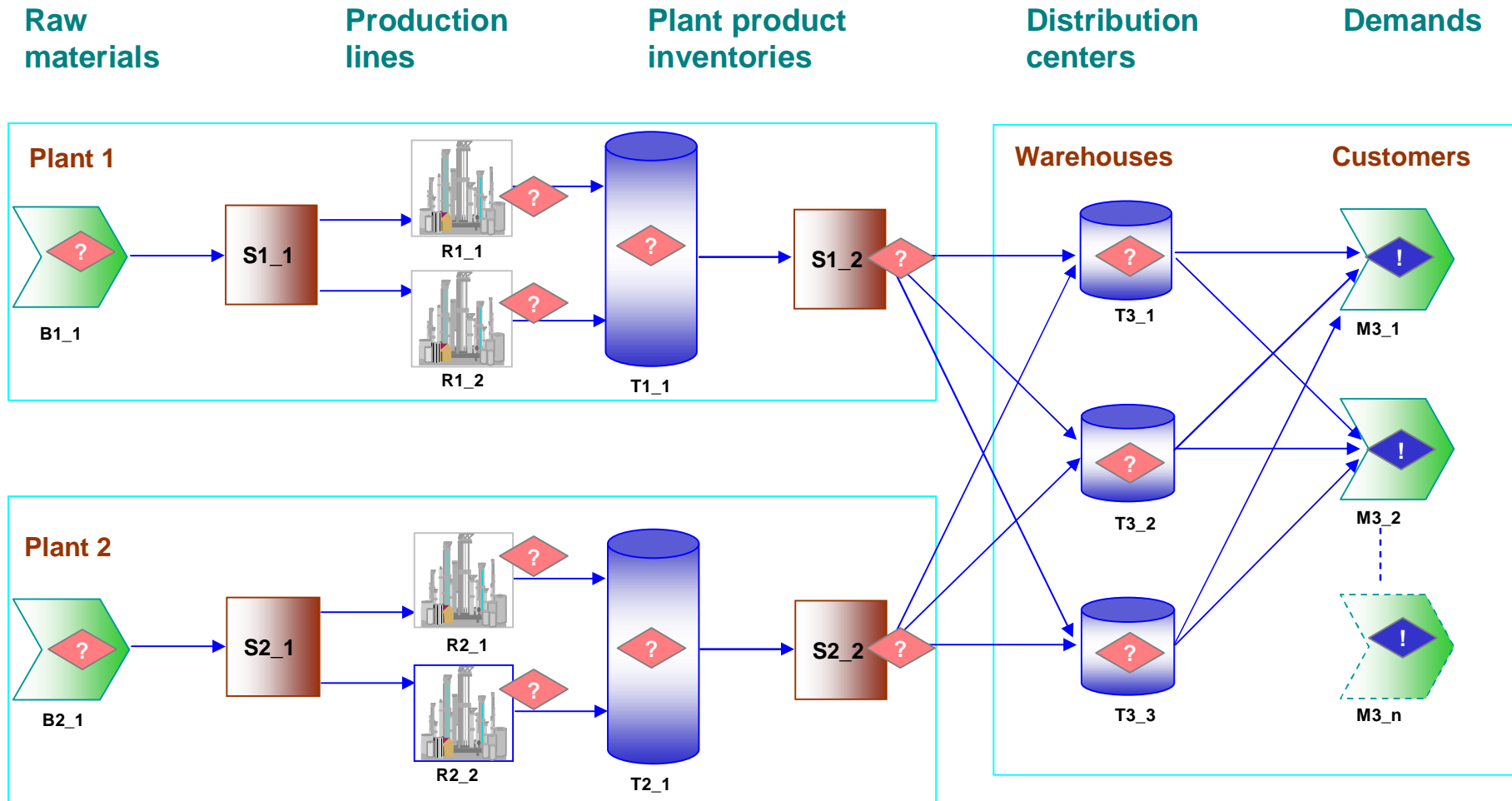
Product	Schedule_Production	Schedule_Percent	Plan_Production	Plan_Percent	Percent_Difference
BD	24853	9.12	24993	9.22	-0.1
C10	9302	3.41	9208	3.4	0.01
ETA	5609	2.06	5435	2.01	0.05
ETY	85799	31.49	87192	32.18	-0.69
GSL	61948	22.74	60098	22.18	0.56
PPA	4419	1.62	0	0	1.62
PPY	40000	14.68	40000	14.76	-0.08
RG	40518	14.87	44023	16.25	-1.38

At the bottom of the window, it says 'Default database: SCart_v0'.

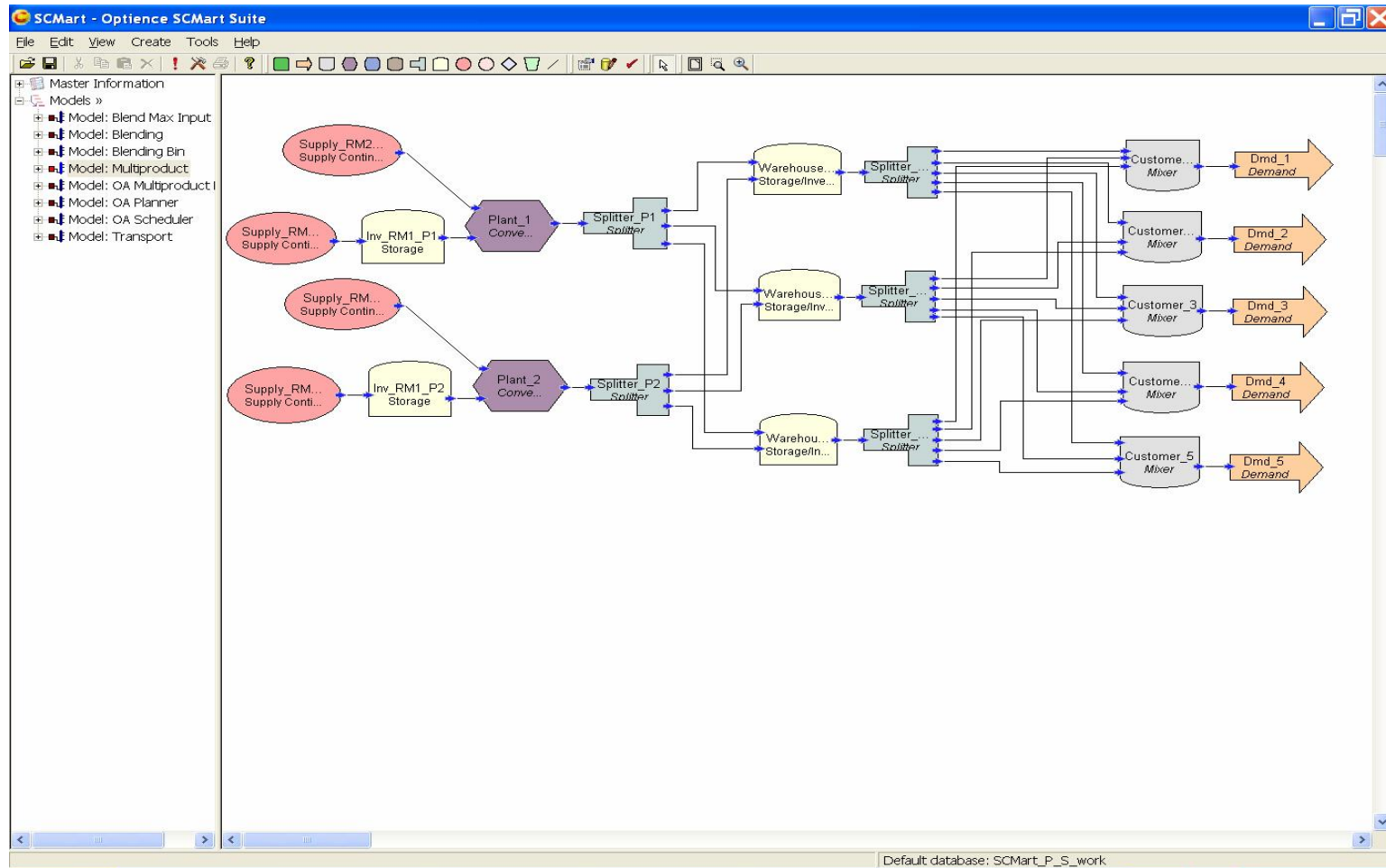
Multi-Products Business Planning & Scheduling

Example – Polymer business

Example: Multi-Products and Multi-Sites Planning



Example – Modeling in SCMart Modeler

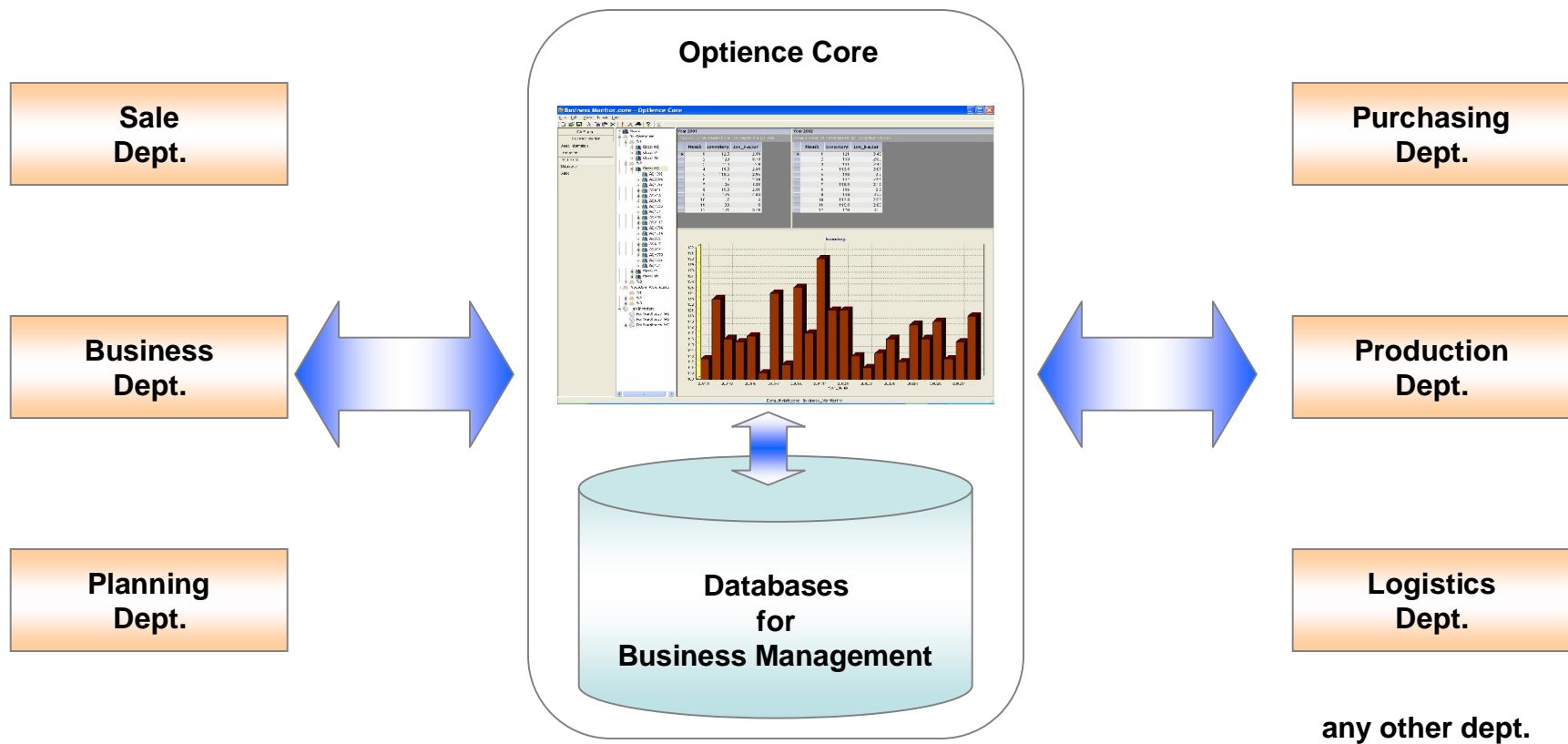


Business Performance Monitoring & Analysis

Example – Multi-products business

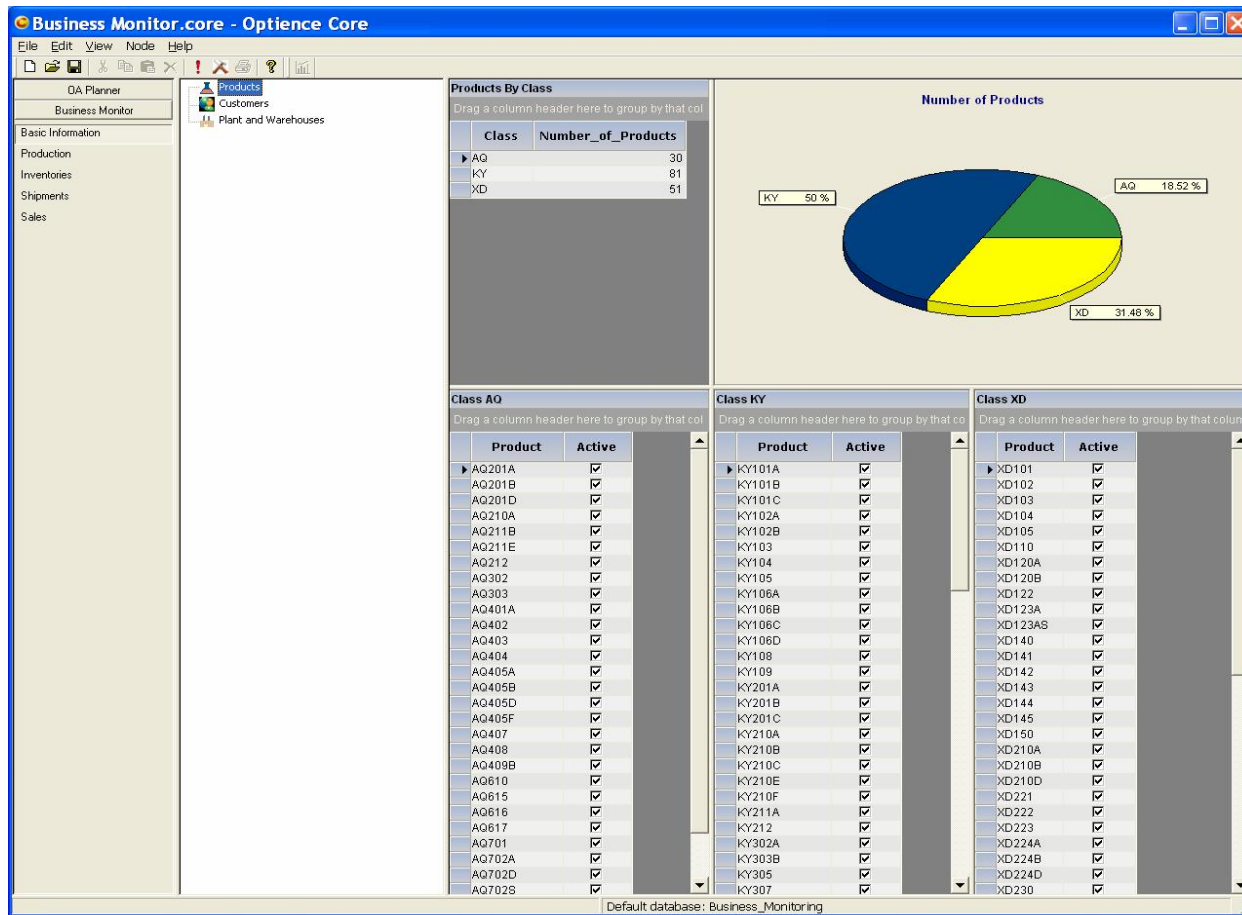
Business Performance Monitoring

- Ø Data sharing & performance analysis
 - » Custom view for each department



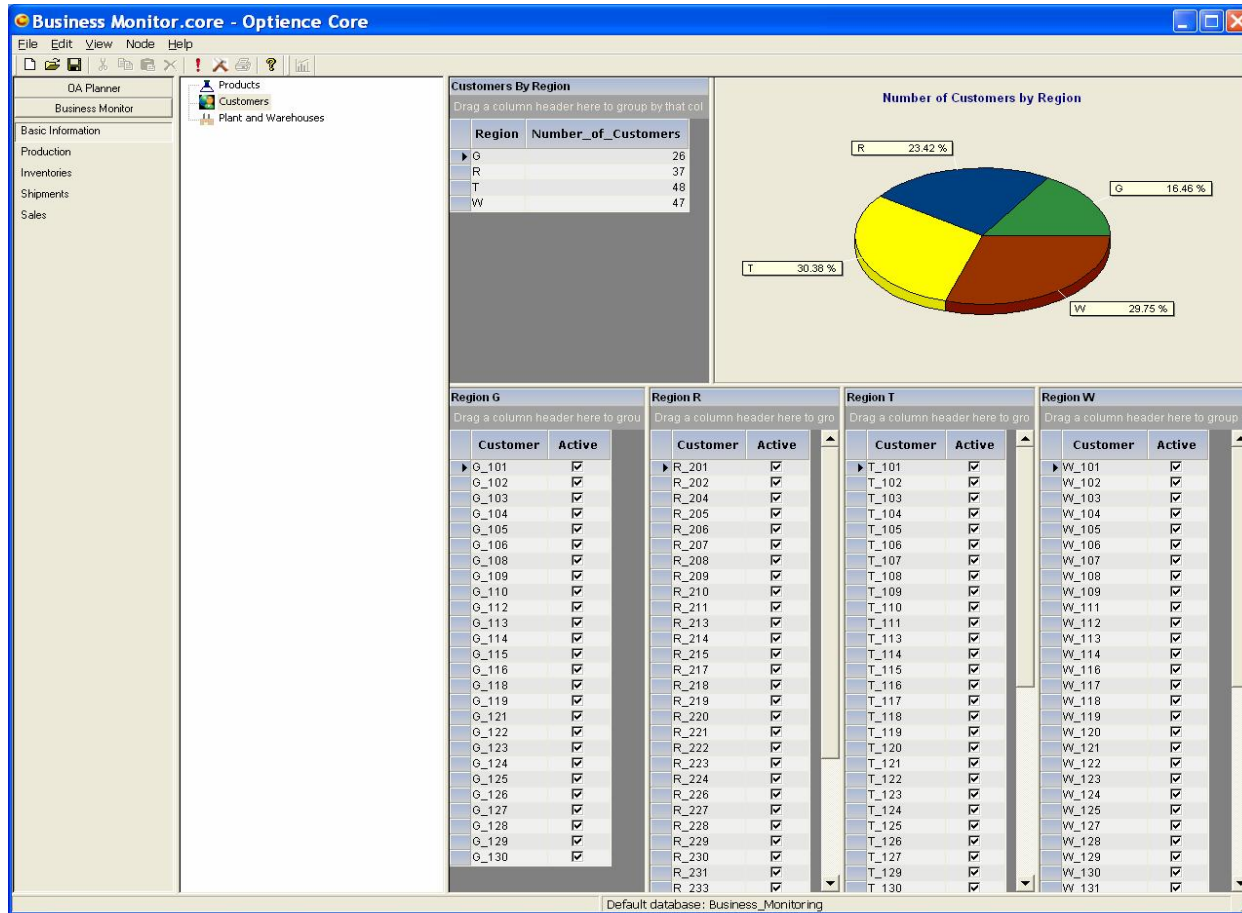
Sample View - Products

Ø Group by product class, product list



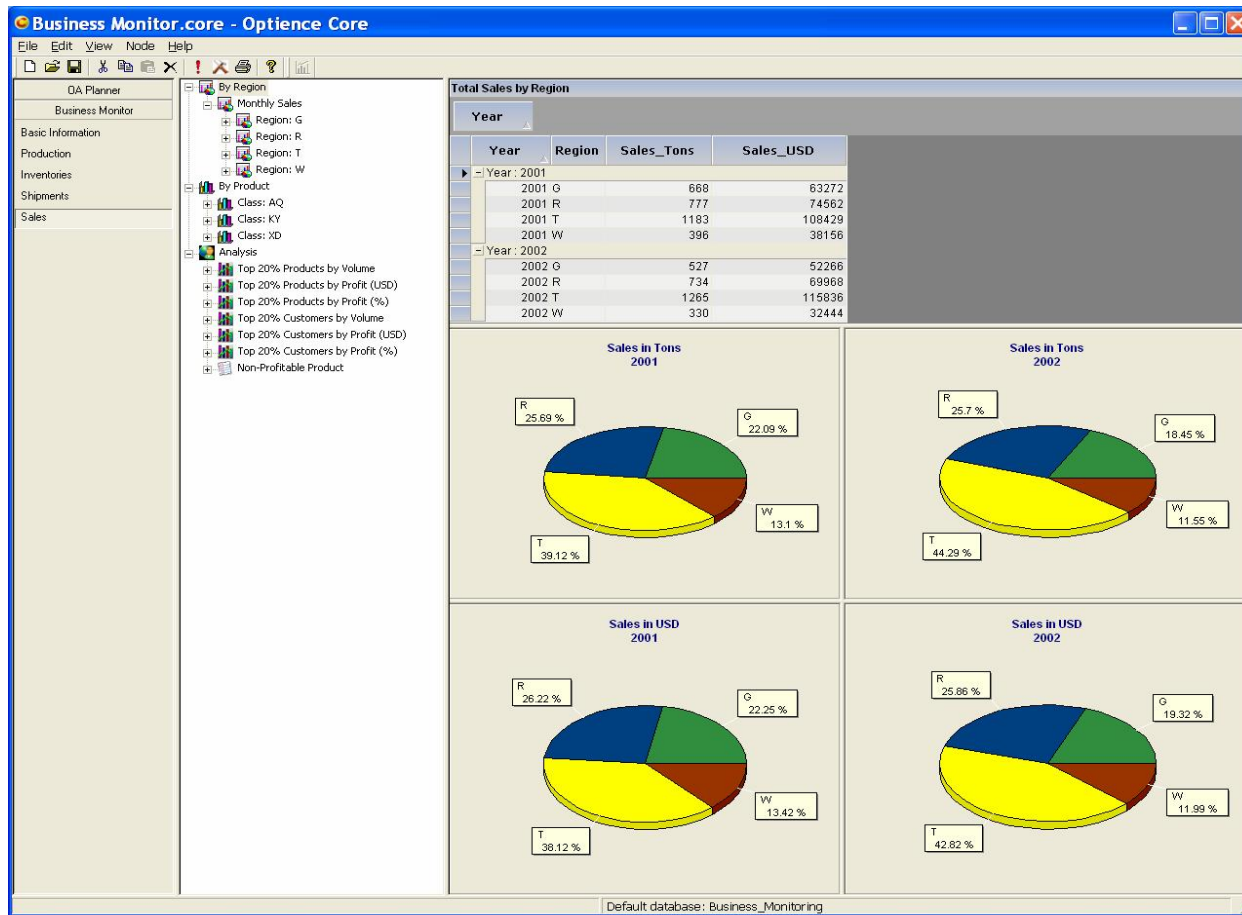
Sample View - Customers

Ø Group by regions



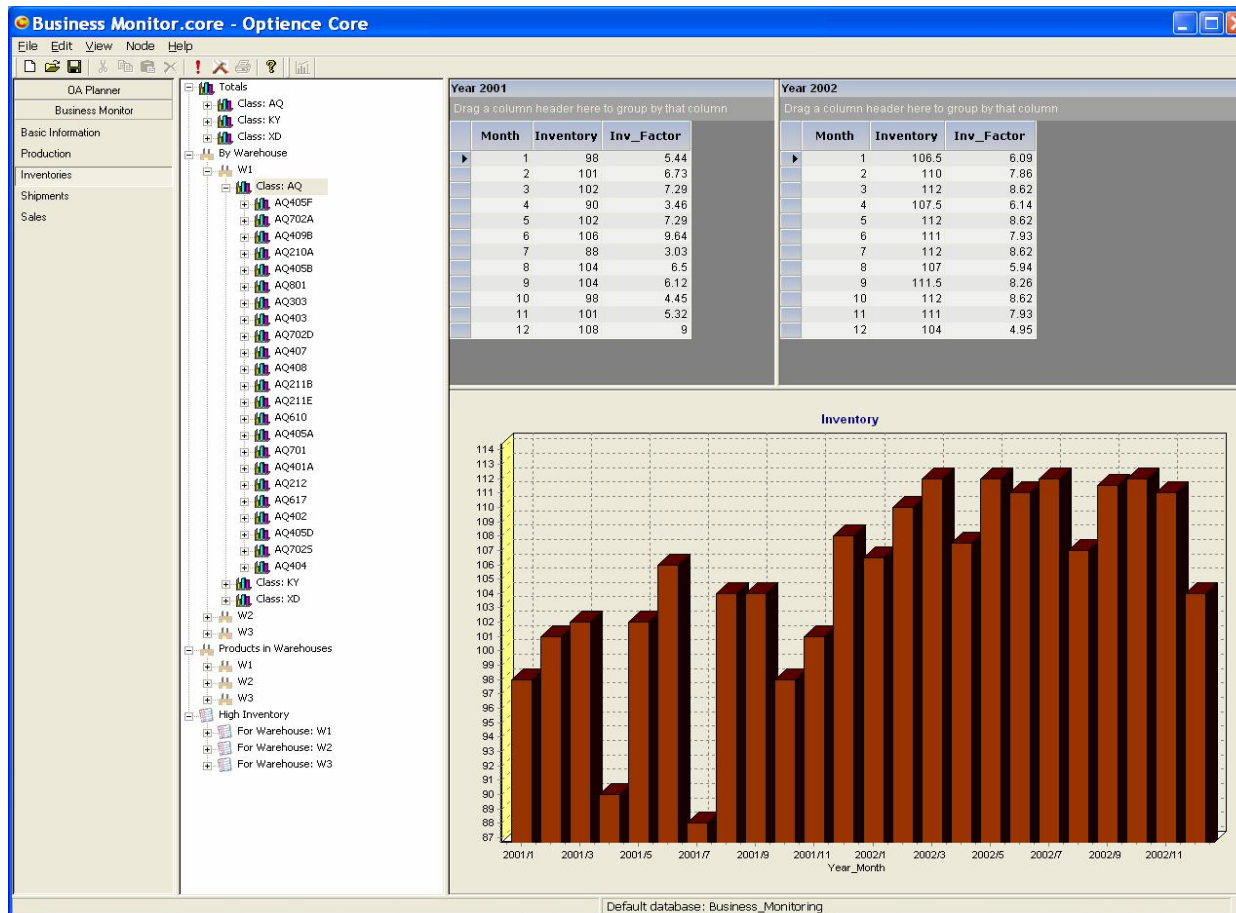
Sample View - Sales

∅ Total – by region



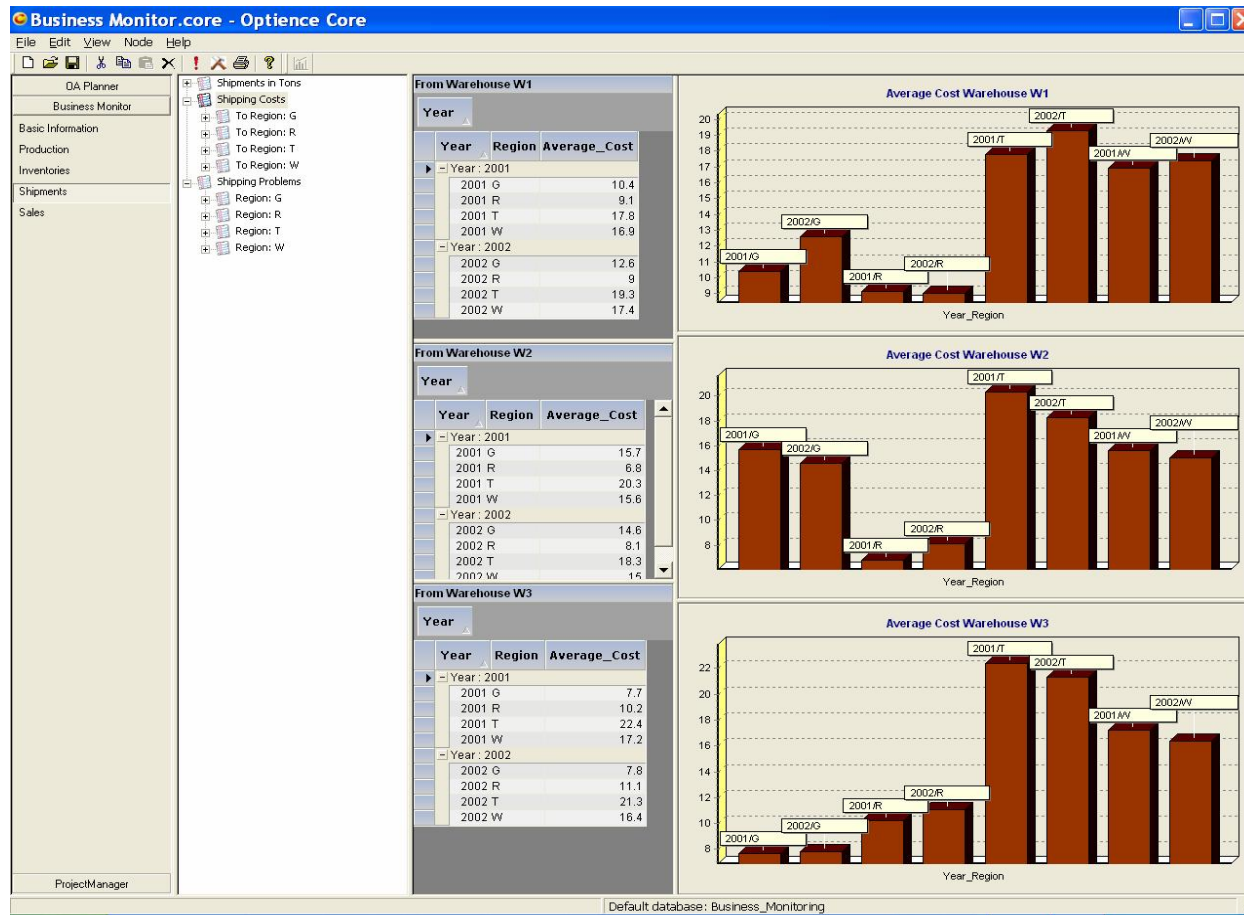
Sample View - Inventory

∅ Total, by warehouse, product class, product



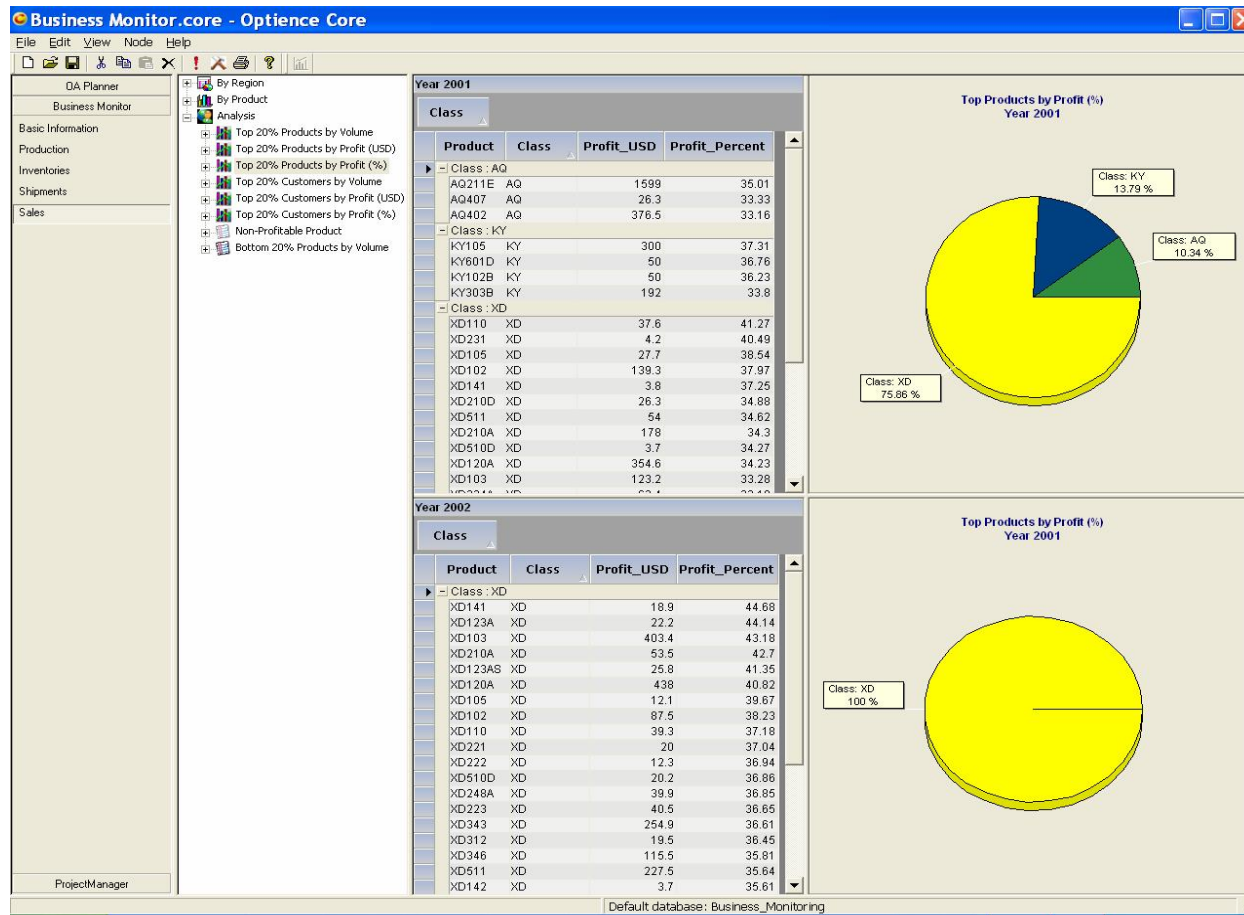
Sample View – Shipping Cost

Ø By regions



Sample View – Sales Analysis

∅ Top 20% most profitable products (\$)



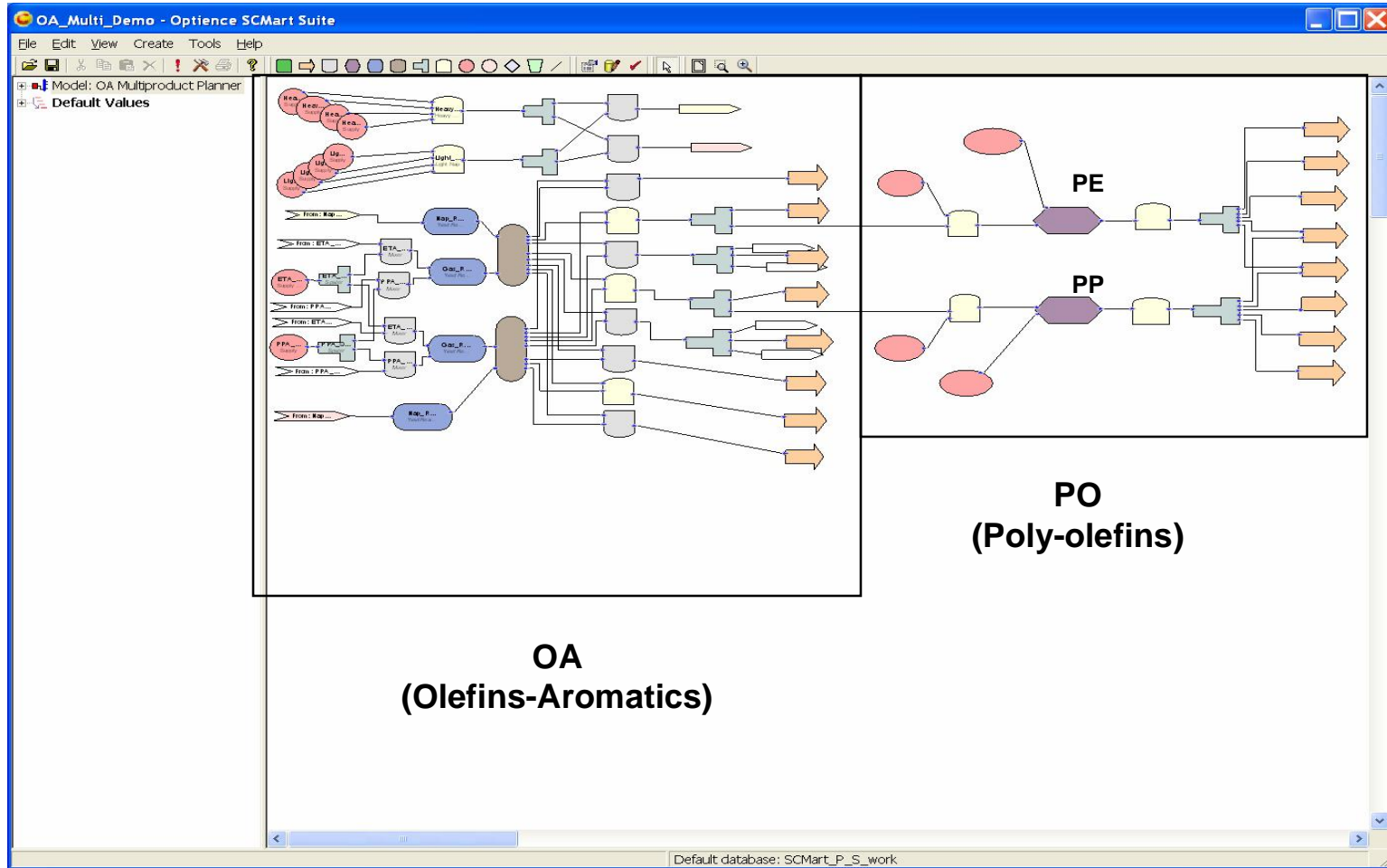
Enterprise Wide Business Planning

Example – OA & PO business



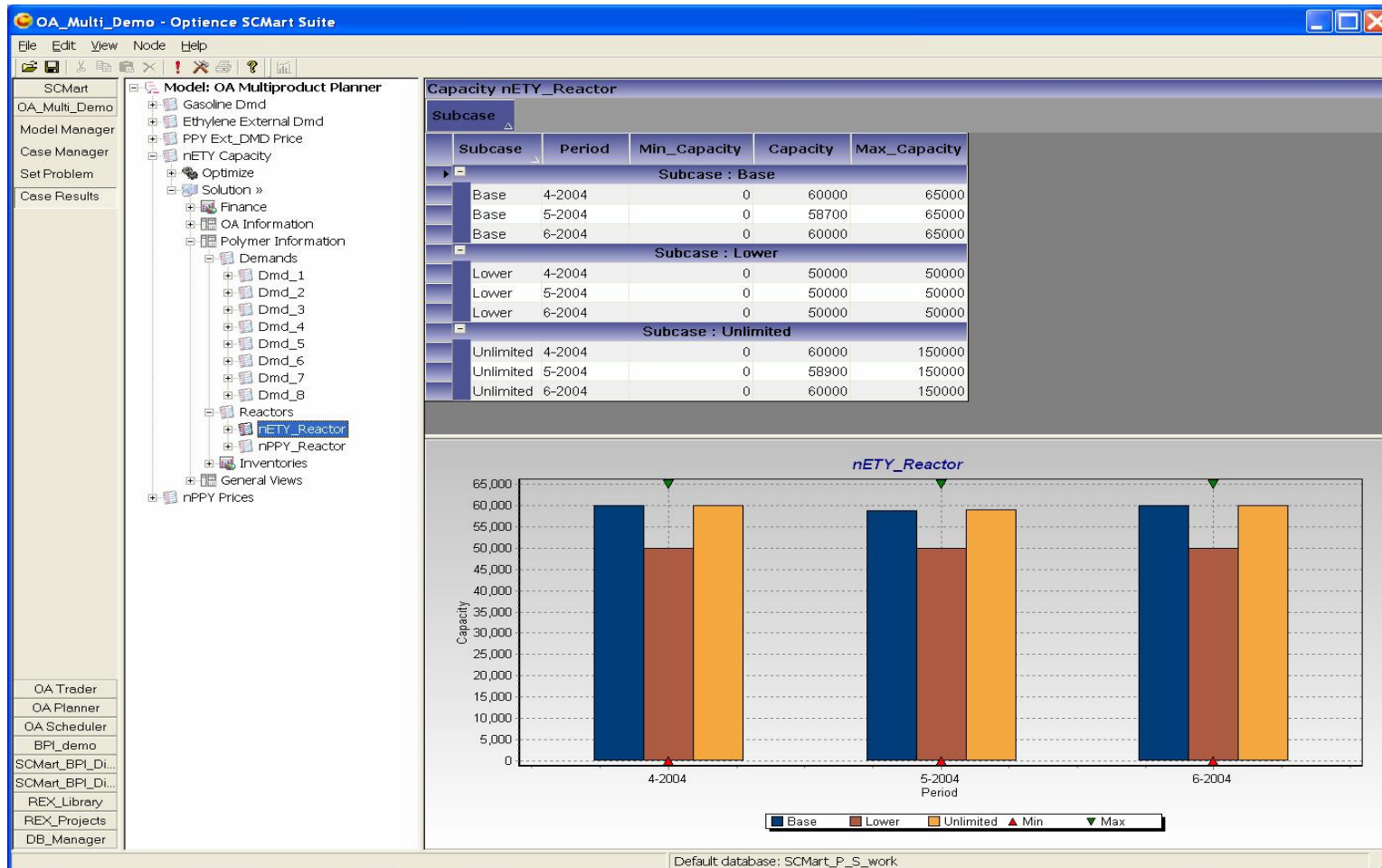
Integrated Planning – OA & PO Business

∅ Model representation



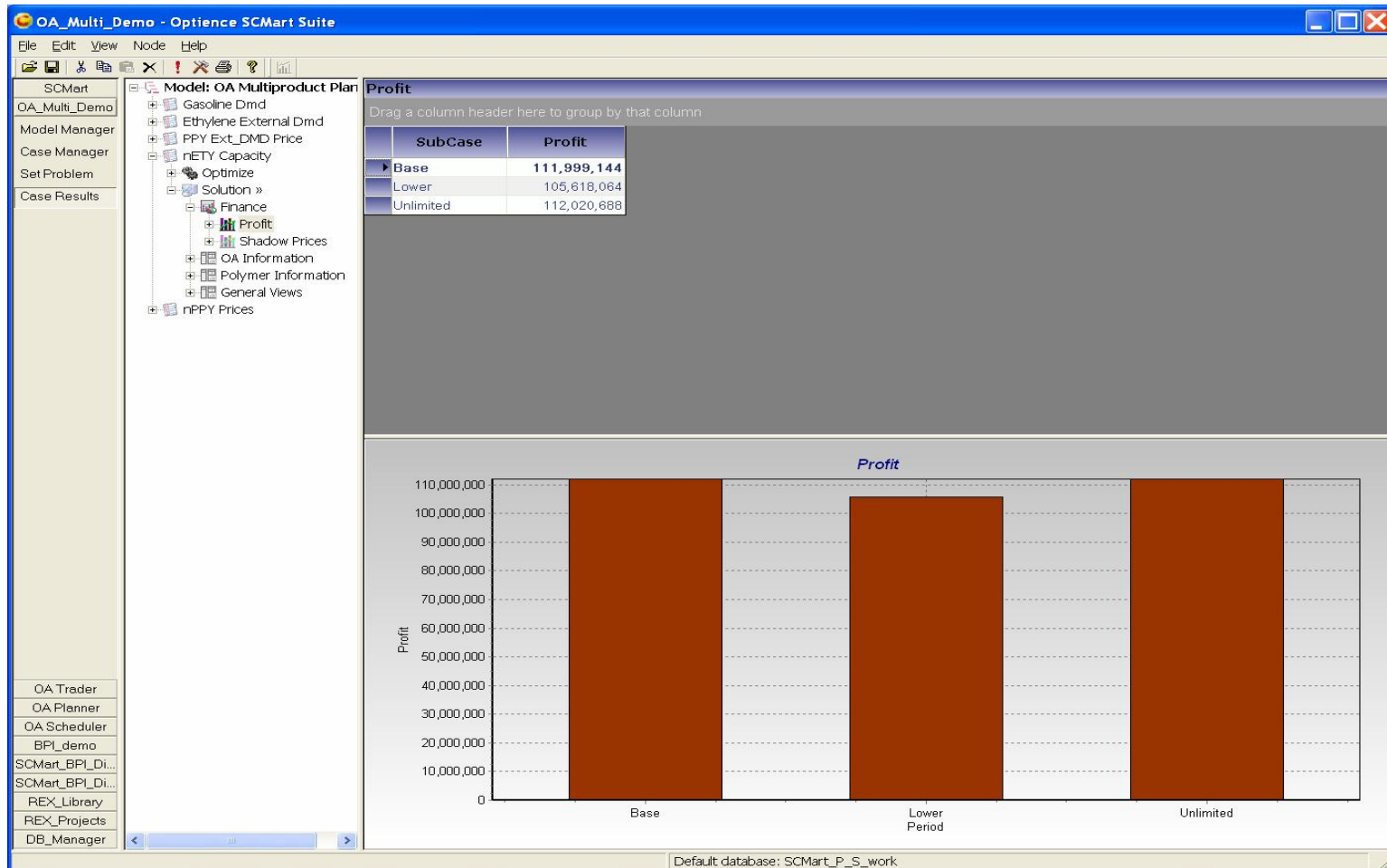
Integrated Planning – OA & PO Business

Ø Result – PE capacity (sub-cases)



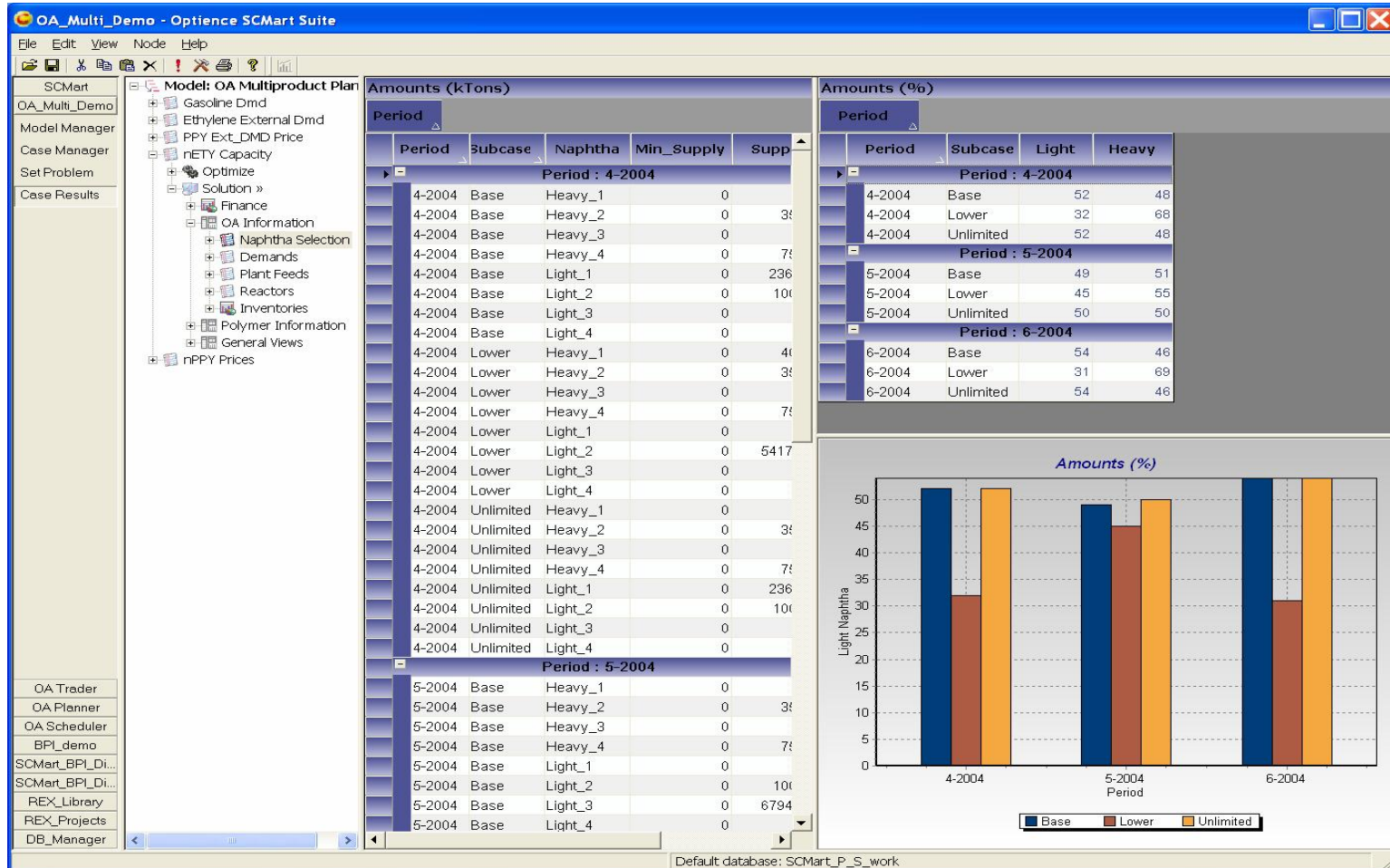
Integrated Planning – OA & PO Business

Ø Result – Profit



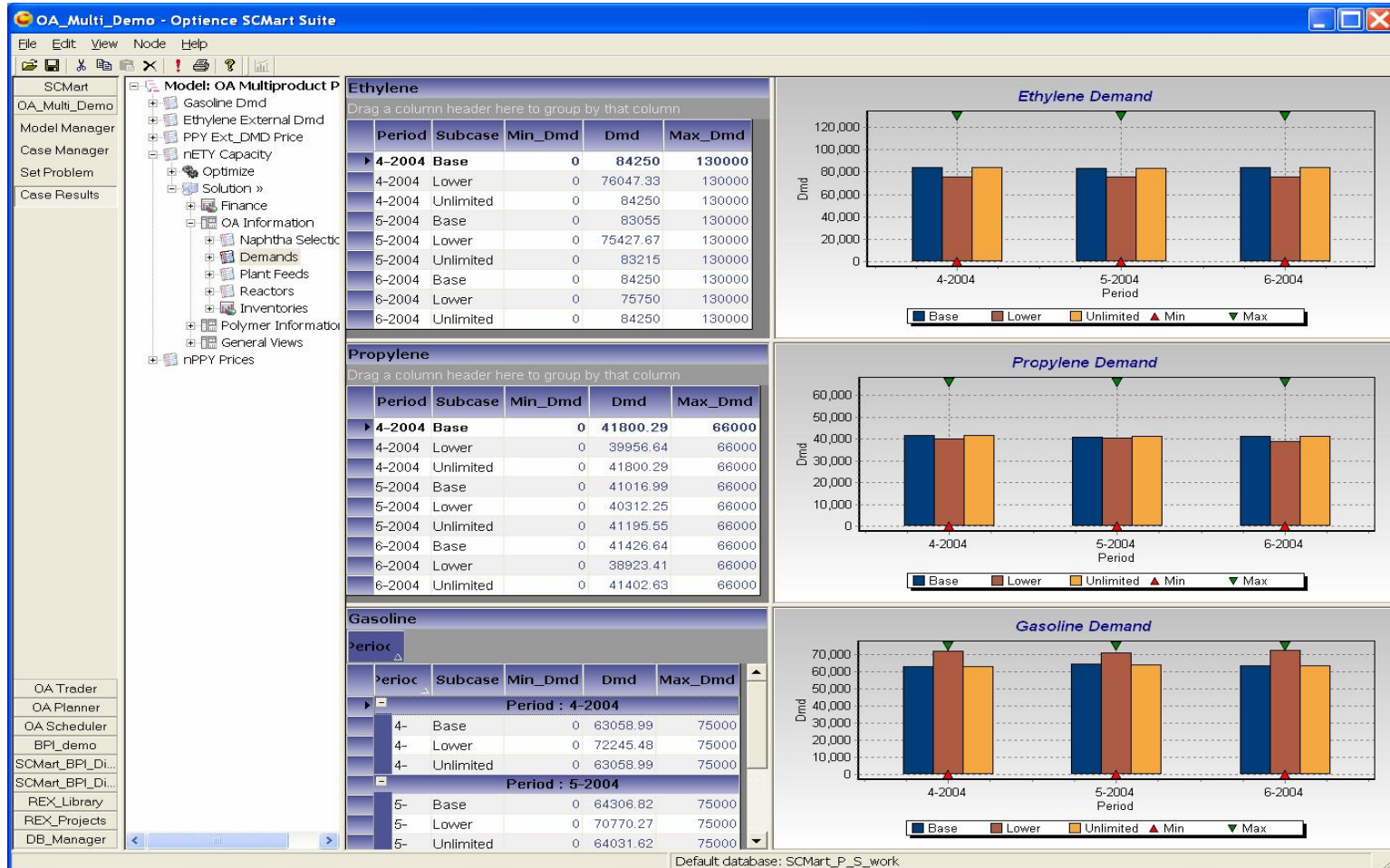
Integrated Planning – OA & PO Business

Ø Result – on Naphtha selections



Integrated Planning – OA & PO Business

Ø Result – OA demands



Summary

- Ø Enterprise wide planning – need one system
 - For business decision support applications

