

Integrated planning solution bolsters supply chain management

The approach uses synergies that exist between various refinery functions to maximize corporate profit

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Supply chain management has been a “buzzword” for some time. A number of papers have described single-site planning and supply chain implementations. A few attempts have been made to integrate the supply chain planning activities across a multisite refining and petrochemical company with some success.

This article describes an integrated planning solution delivered at the Indian Oil Corporation Limited (IOCL). Integrated planning is a critical system that sits at the top of IOCL’s entire supply chain solution. The set of models, software and interfaces that constitute the supply chain solution, in turn, plays a significant role in IOCL’s IT strategy to meet its business objectives.

Company overview. IOCL is India’s No.1 oil company and is listed in the Fortune 500 companies. It is the 19th largest petroleum company in the world and adjudged first in petroleum trading among Asia-Pacific national oil companies for the second year in 2004.

IOCL accounts for 56% of the petroleum products’ marketshare among public companies, 42% of national refining capacity and 69% of downstream pipeline throughput capacity. It has a countrywide sales network of over 23,000 retail points, including over 10,000 gasoline/diesel stations—backed for supplies by 165 bulk storage points, 95 aviation fuel stations and 85 LPG bottling plants. A subsidiary, IBP Co. Ltd., has another 3,000 retail sales points.

IOCL controls 10 of India’s 18 refineries. The corporation owns and operates the country’s largest network of cross-country

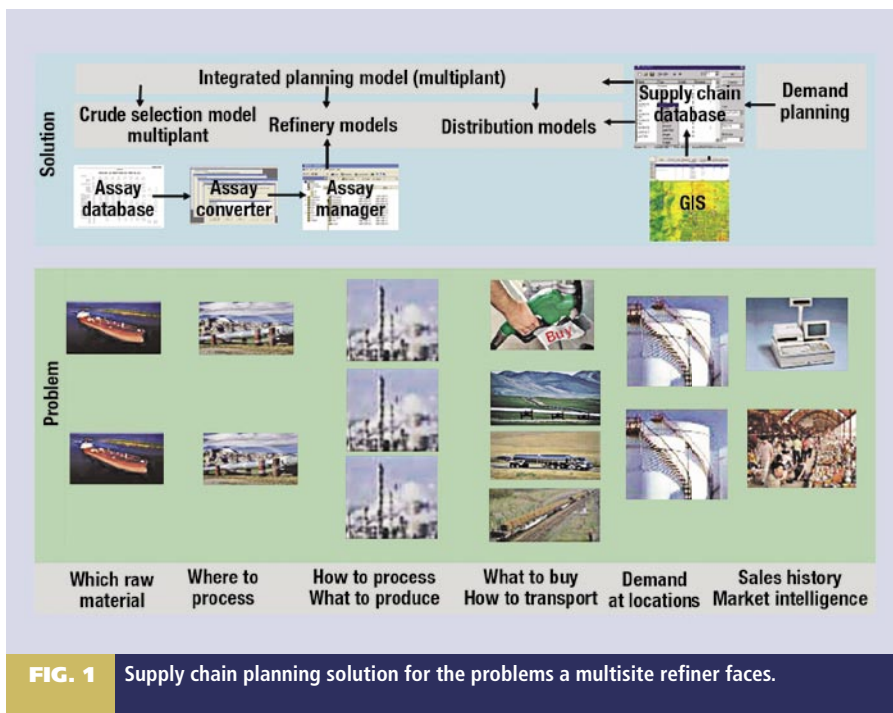


FIG. 1 Supply chain planning solution for the problems a multisite refiner faces.

crude oil and product pipelines of 7,730 km, with a combined capacity of 58.62 million metric ton/year.

To maintain its leadership in the Indian hydrocarbon sector, IOCL implemented an IT reengineering project titled “Manthan.” It includes:

- An enterprise resource planning (ERP) package
- Supply chain management or decision support solutions to optimize IOCL’s entire supply chain.

An international solutions provider with a strong regional presence was chosen as the consultant for implementation of the supply chain solution.

Manthan’s project scope. The implementation of the supply chain solutions for IOCL’s mammoth and complex organization was broken into two phases.

1. The first phase addressed the planning part of the supply chain.
2. The second phase addressed the scheduling and execution parts.

Business problem. The supply chain problem a multisite refining company has to solve consists of multiple decisions:

- Which crude to buy
- Where to process it
- How much to buy and how much to make

TABLE 1. Typical inputs and outputs of the integrated planning model

Inputs

- Crude availability at ports/refineries
- Location level demand (at all terminals/depots/ major customers)
- Desired inventory buildup/depletion
- Committed exports, imports
- Exchanges with OMCs
- Planned shutdown schedule
- Changes in product specifications
- Crude prices/purchase cost
- Product prices
- Yield vectors of extreme-point refineries

Outputs

- Refinery-wide throughput and crude allocation
- Future crude requirement
- Refinery-wide product pattern
- Detailed distribution plan product-wise, mode-wise
- Purchases, exchanges
- Gross margin

- What to make and where
- How to transport it.

Traditionally, different departments or divisions in an organization handle these. Typically, these can be traders, refinery head office, refineries and marketing head office. The marketing home office can also have departments based on product categories. A supply chain solution should optimize not only the operation of each division or department but also the entire corporation. This role is played by an integrated planning solution.

Supply chain planning solution.

The technology provided by the consultant consisted of four main modules:

1. Demand planning: for demand forecasting and aggregation of the final demand numbers based on supply chain requirements
2. Integrated planning: for IOCL's complete supply chain based on demand numbers
3. Distribution planning: generating operational plans for distribution
4. Refinery production planning: generating operational plans for production.

These modules were supported by various enablers that facilitated IOCL's planning activity (Fig. 1). These include: assay database, assay manager and assay conversion utility; supply chain database

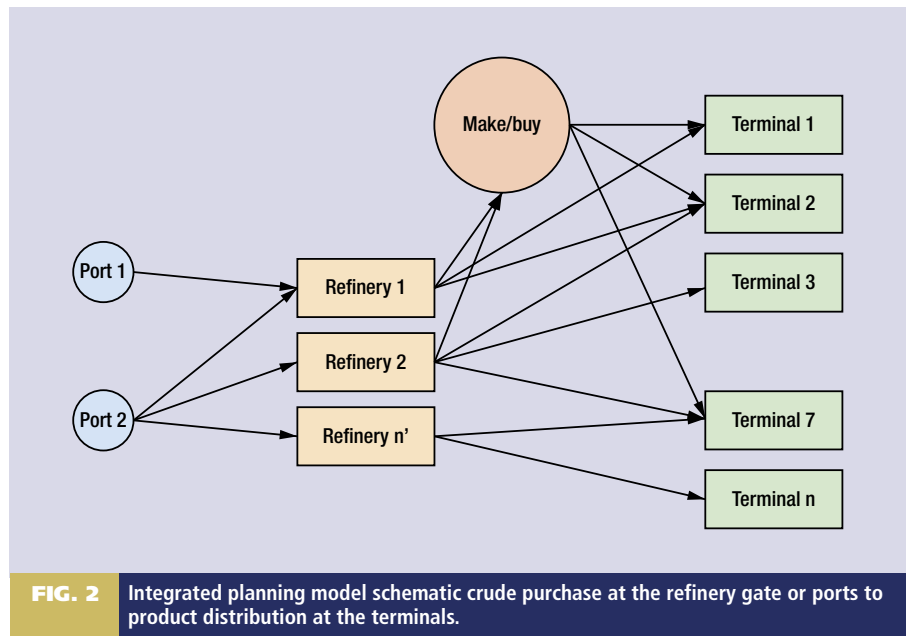


FIG. 2 Integrated planning model schematic crude purchase at the refinery gate or ports to product distribution at the terminals.

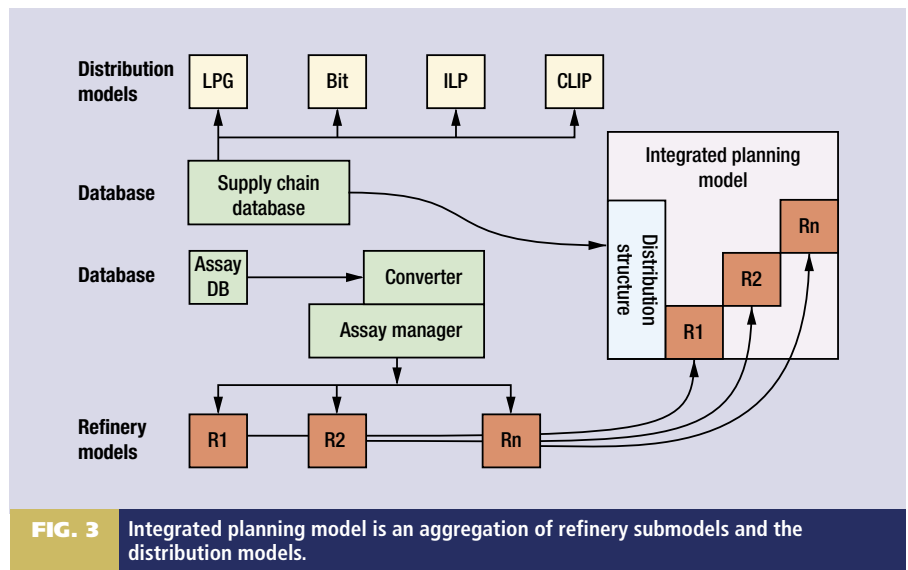


FIG. 3 Integrated planning model is an aggregation of refinery submodels and the distribution models.

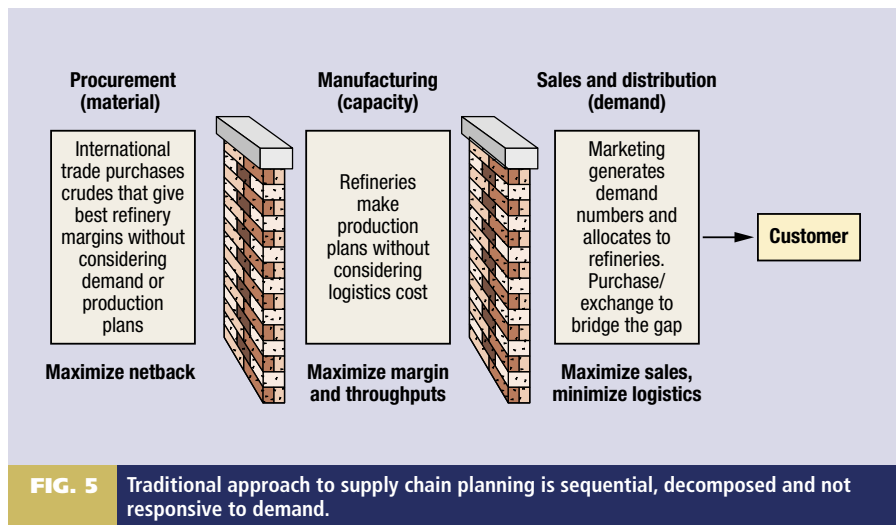
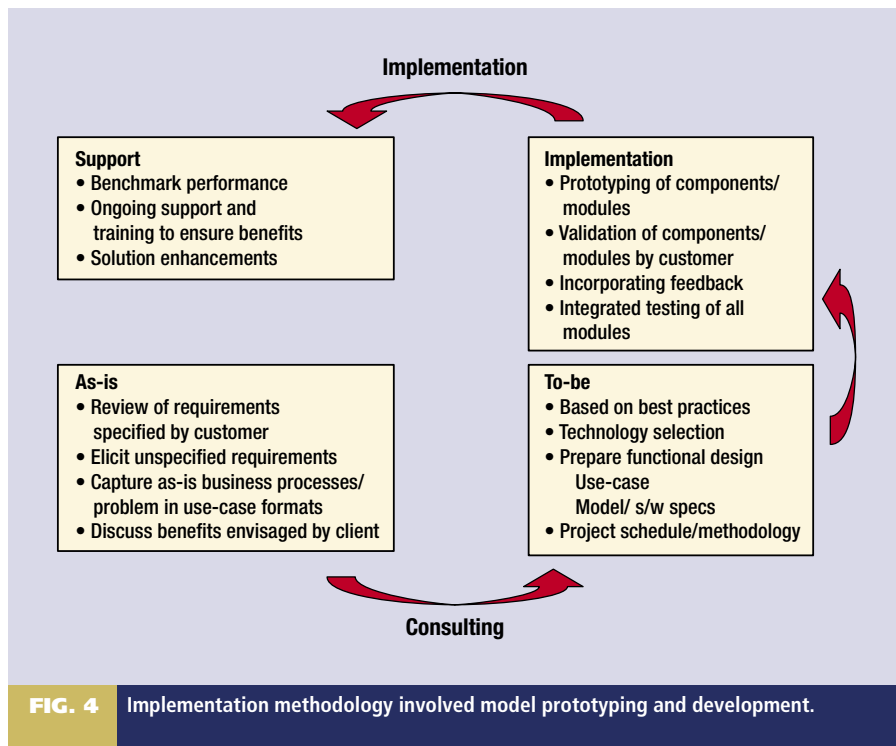
(bolt-on database); geographical information system (GIS); and data interfaces.

To make IOCL's supply chain more responsive to demand, the solution is driven by the demand numbers. Location-wise demands are uploaded into the supply chain database. This is the repository of the entire logistic-related data, which includes static data like modes, terminals/depots and linkages. It also contains dynamic data such as demand data and product prices for depots and terminals, linkage costs based on freight, duties and taxes, and crude availability and costs.

These data are used by the integrated planning model. The model also contains the refinery configuration. The refinery

and the supply/demand structure form the basis on which the optimized plan for the entire corporation is generated. This corporate plan is communicated to distribution models and refinery models to generate operational plans. The optimized plan for the entire corporation is also used as a basis for crude selection runs.

The geographical information system is used to obtain the distances between locations, which is used as a basis for freight calculation. The assay information (for standard cuts) from the assay database is input into the assay manager. The assay manager recuts the crude assay into tower-specific cuts, and the information is used in refinery LP models.



Integrated planning solution. The integrated planning model was developed using refinery LP software with multi-plant features. The model covers IOCL's entire supply chain from crude purchase at the refinery gate or ports to product distribution at the terminals. This makes it one of the largest scopes of this type (Fig. 2).

The three main objectives of the integrated planning model are crude selection, crude allocation to refineries and optimization of the refineries' product pattern. Table 1 shows the typical inputs and outputs of the model.

Supporting models and software.

The integrated planning model is actually an aggregation of refinery submodels and the distribution models (Fig. 3). These models, in turn, require databases to construct them. There is a small difference in the way refinery structure and distribution structure is handled.

The refinery models along with crude assay data are directly embedded in the integrated planning model. Supply and distribution structure is obtained from the supply chain database. This gives flexibility to build in more details in distribution models than what is required from the

perspective of corporate-wide optimization. For example, the distribution model can be industry-wide or have additional transportation constraints.

Assay database, refinery models.

The starting point of a refinery model is crude assay. A third-party crude assay database is used as a source of crude properties (yield and quality of standard cuts). These data are used by the assay manager software for generating yields and qualities for cuts specific to IOCL refineries. Since crude assay updates are provided every quarter, an interface utility was developed to input assay data in text format as provided by the third party into the assay manager.

The assay manager output (crude and vacuum unit yield and properties) is used by the refinery LP models. Each refinery model considers the major process units, blends, inventories and stream routings that have a significant impact on refinery economics during optimization. The optimization is also subject to various economically significant refinery constraints. These constraints include, among others, capacity constraints on major units, quality constraints on products and unit feeds, environmental constraints, evacuation constraints, etc.

Supply chain database, distribution models.

The supply chain database has these functions:

- Temporal integration: Data for yearly and quarterly models are available in one place and can be rolled up or down as required.

- Hierarchical integration: Aggregation for the integrated model is done based on detailed data available for operational distribution models.

- Calculations: Final linkage costs are calculated using tax logic, current prices, distances and freight rates.

The supply chain database provides distribution-related inputs to both the integrated planning and distribution planning models. Integrating the software, models and database required a number of data interfaces. These included middle-ware technology for enterprise application integration, IT infrastructure monitoring tool, and a combination of third-generation language and a relational database management system.

Implementation methodology. A partnership approach was used for imple-

TABLE 2. Factors considered in the integrated approach

- Product demand
- Product prices realizable at the market level
- Logistic costs for crudes and products
- Differentials in prices of marker crudes
- Inter-refinery interactions for meeting the demand
- Evaluation of exchanges, purchases, imports and export options
- Interaction with crudes already procured
- Interaction among refineries for crude allocation encompassing constraints of common pipeline
- Refinery configuration, flexibility and constraints
- Shutdown schedules and availability of process units at refineries

to meet its demand numbers by purchasing the production shortfall from other refiners or selling the excess production to them. Objective of each refinery would be to maximize the throughput and its margin. Crude traders would purchase the crude with best yields or netback based on crude-wise refinery specific yields.

The integrated planning approach uses the synergies that exist between these functions to maximize corporate profit (Fig. 6). Given the large volumes that are involved, small percentage changes translate into huge benefits to the owner.

Table 2 lists factors that are considered in the integrated approach while doing crude selection/planning, which cannot be otherwise considered simultaneously in any one method.

Lessons learned. A successful implementation of this magnitude requires more than just technical competence and team perseverance. It requires excellent skills in the management of the project, people and changes. The following factors significantly contributed to our success:

Change management. Obtain top management support. Identify a high-level sponsor who believes in the end goal. Obtaining employee buy-in is critical. Identify and use process champions. Get end-users involved as early as possible. Have a solid foundation. Perform as-is and to-be analyses. And, finally, ensure that all processes have owners.

Project management. Concentrate on high-value areas. Don't get lost in details: Simplify models where required. Partner with the best consultants in the industry. Have a good project leader who is knowledgeable, empowered and a strong

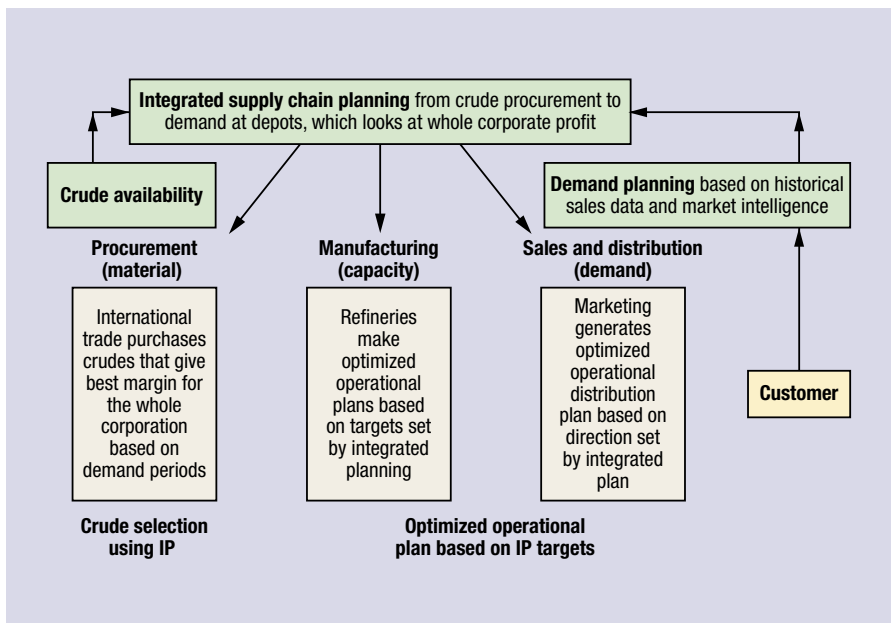


FIG. 6 Integrated supply chain planning approach uses the synergies that exist between various functions to maximize corporate profit.

menting such a challenging project. Both IOCL and the solution provider's resources were involved at each stage. Broadly, these phases were the consulting, implementation and support stages.

The consulting stage started with understanding the as-is processes related to planning. During this time, IOCL employees performing different functions were interviewed at various sites. The output of the consulting stage was the functional design of the solution. This functional design consisted of two parts: 1) "To-be" processes described in use-case narratives, based on best practices and technology available; 2) specifications for models and software previously described.

The implementation stage involved model prototyping and development (Fig. 4). User feedback was applied to fine-tune the models and software. The various models and software were tested individually, eventually in the integrated planning environment. IOCL's involvement in this stage was critical for the technology transfer.

During the support stage, the solution provider helped IOCL in benchmarking the complete planning process. Under the support agreement, the consultants pay regular visits to IOCL sites to ensure that benefits are sustained.

Highlights. Key to project success has been the partnership between IOCL and

its solution provider. A project of this magnitude and complexity requires a change in organization and organizational thinking. The leadership team at IOCL had the vision to make this happen. The best resources were put on the project. These individuals absorbed the technology quickly and championed its cause within the organization.

The project has set a worldwide benchmark in the area of supply chain planning. Some of its special features include:

- Detailed models for five refineries and five extreme point refineries
- Approximately 800 locations (aggregation based on business logic)
- Crude and product pipelines, along with user-specific pipeline constraints
- Multiple modes of transportation
- Setting up the crude selection process using integrated planning.

Benefits. The integrated planning model is being used for production planning for next, annual planning, strategic planning and studies, evaluation of CAPEX in the refineries/pipelines/distribution infrastructure, and crude selection.

The paradigm shift was in doing integrated planning as opposed to the traditional approach, which was sequential, decomposed and not responsive to demand (Fig. 5).

Such an approach led to each department or division optimizing its own operation. The marketing division would try

SYSTEMS MANAGEMENT

leader. Measure and report benefits. Follow standard, good project management practices.

People management. Commit your internal resources for the life of the project. Provide skill development for your identified resources. Address roles and

organization issues early. Reward champions.

Path forward. The next logical step is to consolidate the gains made so far. The plan is to enhance the solution to include select applications in scheduling and the

manufacturing execution systems (MES) domain. The corporate-wide plan generated by integrated planning model could then be implemented through a hierarchy of planning and scheduling models and MES applications. **HP**



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