Chapter 6

Case Study

The Global Oil Company

You may complete the project individually or in groups. In the latter case, which is encouraged, members of the group submit a joint report and all receive the same grade. The ideal size of a group is three. Groups of up to four are allowed. There should be no collaboration among groups and/or students working individually.

The Global Oil Company is an international producer, refiner, transporter and distributor of oil, gasoline and petrochemicals. Global Oil is a holding company with subsidiary operating companies that are wholly or partially owned. A major problem for Global Oil is to coordinate the actions of these various subsidiaries into an overall corporate plan, while at the same time maintaining a reasonable amount of operating autonomy for the subsidiary companies.

To deal with this dilemma, the logistics department at Global Oil Headquarters develops an annual corporate-wide plan which details the pattern of shipments among the various subsidiaries. The plan is not rigid but provides general guidelines and the plan is revised periodically to reflect changing conditions. Within the framework of this plan, the operating companies can make their own decisions and plans. This corporate-wide plan is presently done on a trial and error basis. There are two problems with this approach. First, the management of the subsidiaries often complains that the plan does not reflect properly the operating conditions under which the subsidiary operates. The plan sometimes calls for operations or distribution plans that are impossible to accomplish. And secondly, corporate management is concerned that the plan does not optimize for the total company.

The technique of linear programming seems a possible approach to aid in the annual planning process, that will be able to answer at least in part, the two objections above. In addition the building of such a model will make it possible to make changes in plans quickly when the need arises. Before embarking on the development of a world-wide model, Global Oil asks you to build a model of the Far Eastern operations for the coming year.

Far Eastern Operations

The details of the 1998 planning model for the Far Eastern Operations are now described.

There are two sources of crude oil, Saudi Arabia and Borneo. The Saudi crude is relatively heavier (24 API), and the Far Eastern sector could obtain as much as 60,000 barrels per day at a

cost of $18.50 per barrel during 1998. A second source of crude is from the Brunei fields in Borneo. This is a light crude oil (36 API). Under the terms of an agreement with the Netherlands Petroleum Company in Borneo, a fixed quantity of 40,000 b/d of Brunei crude, at a cost of $19.90 per barrel is to be supplied during 1998.

There are two subsidiaries that have refining operations. The first is in Australia, operating a refinery in Sydney with a capacity of 50,000 b/d throughput. The company markets its products throughout Australia, as well as having a surplus of refined products available for shipment to other subsidiaries.

The second subsidiary is in Japan, which operates a 30,000 b/d capacity refinery. Marketing operations are conducted in Japan, and excess production is available for shipment to other Far Eastern subsidiaries.

In addition, there are two marketing subsidiaries without refining capacity of their own. One of these is in New Zealand and the other is in the Philippines. Their needs can be supplied by shipments from Australia, Japan, or the Global Oil subsidiary in the United States. The latter is not a regular part of the Far Eastern Operations, but may be used as a source of refined products.

Finally, the company has a fleet of tankers that move the crude oil and refined products among the subsidiaries.

Refinery Operations

The operation of a refinery is a complex process. The characteristics of the crudes available, the desired output, the specific technology of the refinery, etc., make it difficult to use a simple model to describe the process. In fact, management at both Australia and Japan have complex linear programming models involving approximately 300 variables and 100 constraints for making detailed decisions on a daily or weekly basis.

For *annual* planning purposes the refinery model is greatly simplified. The two crudes (Saudi and Brunei) are input. Two general products are output – (a) gasoline products and (b) other products such as distillate, fuel oil, etc. In addition, although the refinery has processing flexibility that permits a wide range of yields, for planning purposes it was decided to include only the values at highest and lowest conversion rates (process intensity). Each refinery could use any combination of the two extreme intensities. These yields are shown in Table 6.1.

The incremental costs of operating the refinery depend somewhat upon the type of crude and process intensity. These costs are shown in Table 6.1. Also shown are the incremental transportation costs from either Borneo or Saudi Arabia.

Marketing Operations

Marketing is conducted in two home areas (Australia and Japan) as well as in the Philippines and New Zealand. Demand for gasoline and distillate in all areas has been estimated for 1998.

Area	**1998 Demand (thous. of b/d)**	
	Gasoline	Distillate
Australia	9.0	21.0
Japan	3.0	12.0
Philippines	5.0	8.0
New Zealand	5.4	8.7
TOTAL	**22.4**	**49.7**

Table 6.1: Refinery Operations

	Australia	Japan
Capacity (b/d of input)	50,000	30,000
Saudi Crude		
Transportation Cost ($/b)	0.65	0.70
High Process Intensity ($/b)	1.19	1.26
Yield of Gasoline	0.31	0.30
Yield of Distillate	0.61	0.62
Low Process Intensity ($/b)	0.89	0.88
Yield of Gasoline	0.19	0.18
Yield of Distillate	0.73	0.74
Brunei Crude		
Transportation Cost ($/b)	0.15	0.25
High Process Intensity ($/b)	0.93	0.91
Yield of Gasoline	0.36	0.35
Yield of Distillate	0.58	0.59
Low Process Intensity ($/b)	0.61	0.55
Yield of Gasoline	0.26	0.25
Yield of Distillate	0.69	0.70

Variable costs of supplying gasoline or distillate to New Zealand and the Philippines are:

Variable costs of shipment of gasoline/distillate in $/b

From:	To: New Zealand	Philippines
Australia	.20	.30
Japan	.25	.40

Tanker Operations

Tankers are used to bring crude from Saudi Arabia and Borneo to Australia and Japan and to transport refined products from Australia and Japan to the Philippines and New Zealand. The variable costs of these operations are included above.

However, there is a limited capacity of tankers available. The fleet has a capacity of 6.5 equivalent (standard sized) tankers.

The amount of capacity needed to deliver one barrel from one destination to another depends upon the distance traveled, port time, and other factors. The table below lists the fraction of one standard sized tanker needed to deliver 1,000 b/d over the indicated routes.

Tanker Usage Factors

(Fraction of Standard Sized Tanker Needed to Deliver 1,000 b/d)

Between	and Australia	Japan
Saudi Arabia	.12	.11
Borneo	.05	.05
Philippines	.02	.01
New Zealand	.01	.06

It is also possible to charter independent tankers. The rate for this is $5,400 per day for a standard sized tanker.

United States Supply

United States operations on the West Coast expect a surplus of 12,000 b/d of distillate during 1998. The cost of distillate at the loading port of Los Angeles is $20.70 per barrel. There is no excess gasoline capacity. The estimated variable shipping costs and tanker requirements of distillate shipments from the United States are:

	Variable costs of shipments	**Tanker requirements**
New Zealand	1.40	.18
Philippines	1.10	.15

Questions

Part I: Formulate a linear program which can be used to generate a comprehensive plan for the whole Far Eastern operations. Clearly define every variable used in your formulation.

Each group should be prepared to make a presentation of their linear programming model in class, on September 22. No written report is due on this date.

Part II: Written report due on October 6. Start your report with an executive summary (at most two pages) containing the most important results and recommendations. Attach supporting material in Appendices.

1. Solve your linear program using SOLVER.

   How many barrels of crude should Global Oil purchase from Saudi Arabia for its Far Eastern operations? How much crude should be refined in Australia? How much in Japan? Provide tables showing the quantities of gasoline and distillate shipped from each of the two refineries and from the U.S. to each of the four market areas.

2. Use sensitivity analysis to answer the following questions.
   - What is the marginal value of increasing supply from Brunei fields? Can this marginal value be used to estimate the total savings for Far Eastern operations if 41,000 b/d are supplied from Brunei fields instead of 40,000? Explain.
   - What is the marginal value of increasing the tanker fleet? Can this marginal value be used if we want to increase the size to 7 tankers (from the current size of 6.5)? Explain.
   - What is the additional cost to Far Eastern operations if demand for gasoline in the Philippines increases to 5,200 b/d? What is the minimum price of gasoline in the Philippines that would make it profitable for Global Oil to consider such an increase in distribution?
   - By how much should the production costs be reduced at the refinery in Japan when operating at high process intensity in order to make it cost effective to use Saudi crude?
   - Global Oil is planning a three day shutdown of its Australian refinery for maintenance purposes, in the coming year. It has storage facilities and at least two weeks of inventories, so a refinery shutdown for a few days will not disrupt distribution. What would be the cost of a planned shutdown of the refinery in Australia for three days per year? Same question for the refinery in Japan.
   - Currently, it is not economical to ship US distillate to the Philippines. What is the cost of US distillate at which Global Oil should consider starting such shipments?

3. Several opportunities present themselves to the Global Oil company (see the attached memos). Consider combinations of these options and prepare a recommendation. Document your report.

Memo to: Global Oil Headquarters

From: Australian Affiliate

Re: Supplements to Annual Plan

Since submitting data for annual planning purposes, two additional opportunities have arisen. We would like to include these in the plans.

A. Bid on Gasoline Contract with Australian Government

The government of Australia will submit to bid a contract for 1.5 thousand b/d of gasoline. We expect we could win this bid at a price of $26.40 per barrel. Estimated costs per barrel as follows:

Variable Costs (crude, refining, transportation)	$24.90
Allocated Overhead	.80
Total	**$25.70**

At these costs, the contract would have a profit contribution of $0.70 per barrel. We would like permission to bid on the contract. We hope that the linear programming wizards who are working for your logistics department will not contradict us!

B. Expansion of Australian Refinery

For the past two years, the Australian refinery has been operating at full capacity. We request authorization for capital expenditures to increase the refinery capacity to 55 thousand b/d. There are several reasons for the need for this expansion:

1. Australia can supply the current requirements in New Zealand and the Philippines more cheaply than can Japan.
2. The proposed bid on Australian government gasoline contract (above).
3. We understand the New Zealand affiliate is considering increasing its requirements by 4.5 thousand b/d. (See below.)

The cost of this expansion is 4.0 million dollars. To recover this investment[1], we need an annual savings of $702,000.

[1]This assumes a cost of capital rate of 20%. Depreciation tax effects are included. With these considerations, the $702,000 savings per year is equivalent to the $4 million investment

Memo to: Global Oil Headquarters

From: New Zealand Affiliate

Re: Supplement to Annual Plan

Negotiations have been begun with the NOZO Oil Company in New Zealand. This company is a distributor, with sales of 1.6 thousand b/d of gasoline and 3.2 thousand b/d of distillate. If negotiations are successfully completed, these requirements would be added to current requirements for New Zealand, making total requirements of:

Gasoline: 7.0 thousand b/d

Distillate: 11.9 thousand b/d

The anticipated revenue (after subtracting variable marketing costs) for this acquisition are \$30.20 per barrel for gasoline and \$24.60 per barrel for distillate. The purchase cost of NOZO oil is expected to be about \$21.0 million. On an annual basis, this would require \$3.5 million per year incremental profit to justify the purchase.

Memo to: Global Oil Headquarters

From: Tanker Affiliate

Re: Supplement to Annual Plan

We have been made aware that expansions in requirements are being considered in New Zealand and Australia. We are currently operating the tanker fleet at capacity. Additional requirements will increase the transport requirements both for crude and refined products. This will necessitate spot chartering unless additional tanker capacity is added.

We can lease on a long time basis additional tankers at a rate of \$4.8 thousand dollars per day per 1 unit tanker equivalent. We propose a lease of 0.5 equivalent tanker units giving us a total capacity of 7.0 equivalent units. The cost of this would be \$2.4 thousand per day or \$876,000 per year. If you prefer other arrangements, we are willing to discuss them.

Memo to: Global Oil Headquarters

From: Borneo Office

Re: Supplement to Annual Plan

We have just been offered the opportunity to increase our contract with our supplier of Brunei crude. They are willing to supply us an additional 5 thousand b/d at a cost of \$20.65 per barrel. Should we accept the offer? If not, is there a counter offer that we should propose?