

New Horizons in Simulation Games and Experiential Learning, Volume 4, 1977

PETROLEUM MANAGEMENT GAME-1975 (PMG75)

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GENERAL DESCRIPTION

The petroleum “economy,” as the term is used here, represents a hypothetical environment in which oil companies are competing. The economy is closed and exists within the simulated national economy. A few of the more important assumptions and restrictions made in the model are listed below:

- a) The initial size and number of oil companies in the simulation is variable. Up to a maximum of eight competing companies, with one additional company programmed internally to simulate the aggregate effect of independent competition.
- b) The petroleum products are limited to premium, regular and unleaded gasoline, distillate and residual fuel oil, jet fuel and petrochemicals. The quality characteristics of the products are generated by the model and are not affected by players’ decisions.
- c) The products are marketed in retail, wholesale (industrial and commercial), and unbranded jobber markets. In each market, the competing companies are assigned an initial share, with aggregate independent competition taking the remainder. There is no geographic division of the markets.
- d) All refining improvements and operations are slanted toward maximum gasoline production at the market octane level. New capital may be assigned to increase petrochemical capacity.
- e) Transfers, exchanges, and agreements on petroleum products among the various competing companies are not allowed. In this connection, joint drilling ventures are not permitted.
- f) The simulated national economy is extrapolated from that in existence in the United States in the period 1970-1975. The petroleum economy represents a fixed percentage of the national economy with respect to income and demand patterns.
- g) Each play is considered to the decision inputs are separated into those capital budgeting decisions which are only made annually, or every fourth playing quarter, and those operational decisions which must be made each quarter.

The management team for each company makes its decisions on the basis of operational and financial data which the model

produces from the previous period, or from an initial situation furnished to the players. Every company is assumed to be a net purchaser of crude, and the price that the companies must pay for this crude depends partly on the posted prices, so that the largest producers have more influence on the price that all have to pay.

DESCRIPTION OF THE GAME

The activity in this model of the petroleum industry is concentrated in the areas of exploration and production, refining, marketing, and administration. A brief description given in the following sections. Each section describing the decisions required of the players and output returned to them after each computer run.

A. Production

Required Input Decisions:

- | | | |
|------------|----|------------------------------------------|
| Annual: | 1. | Total Production Budget |
| | 2. | Allocation for leasing |
| Quarterly: | 1. | Amount budgeted for development drilling |
| | 2. | Amount budgeted for exploratory drilling |
| | 3. | Average depth of exploratory wells |
| | 4. | Posted price of crude |

Computer Generated Output:

1. Total production of crude (barrels)
2. Producing acreage held
3. Non-producing acreage held
4. Total producing wells owned
5. No. of successful exploratory wells this quarter
6. No. of dry exploratory wells this quarter
7. No. of successful development wells this quarter
8. No. of dry development wells this quarter
9. Footage drilled this quarter
10. Unit cost of production
11. Reserve additions this quarter (barrels)
12. Net proven reserves

Total production depends on proven reserves and number of producing wells.

The number of successful exploratory wells is subject to a large random variation, reflecting the uncertainty of exploratory operations. The average value, however, depends on capital available for leasing, exploration, drilling, and a “success ratio” which depends on average depth and on research expenditures during the past few years.

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The number of successful development wells is subject to a small random variation. It depends strongly on capital available for development drilling and average cost of drilling. Reserve additions reflect a trend toward smaller discoveries per successful well as time goes by, but there is a sizable random effect on this variable.

Both mid-continent and offshore (featuring competitive lease bidding with higher drilling costs, but much greater reserve additions and productive capacity per well) models are included.

The total production budget must be set annually. It includes all operating expenses, land leasing expenses, and capital for exploratory and developmental drilling for the year. The budget for land leasing is pro-rated equally to each quarter and, of course success in exploration depends considerably on leasing activity.

It is necessary to spend capital for development drilling to increase production. Additions to net reserves can be brought about only by capital expenditures for exploratory and development drilling.

The probability of success increases with average well depth, but the per-foot cost also increases. There is therefore an optimum value for average depth.

The price paid per crude purchased to meet manufacturing needs in excess of production for each company is a weighted average of posted crude prices. It is therefore desirable to examine your production and throughput relative to competitors to determine advantages of a price increase or decrease.

B. Refining

Required Input Decisions:

- | | | |
|------------|----|-------------------------------------|
| Annual: | 1. | Total manufacturing budget |
| | 2. | Capital for Expansion |
| | 3. | Capital for Modernization |
| | 4. | Capital for Petrochemicals |
| Quarterly: | 1. | Crude runs to refineries |
| | 2. | Premium gasoline to be manufactured |
| | 3. | Regular gasoline to be manufactured |
| | 4. | Petrochemicals to be manufactured |

Computer Generated Output:

- | | |
|----|-----------------------------------------|
| 1. | Crude inventory at beginning of quarter |
| 2. | Crude storage capacity |
| 3. | Max. gasoline pool |
| 4. | Operating level |
| 5. | Products manufactured |

- a. premium gasoline
- b. regular gasoline
- c. unleaded gasoline*
- d. distillate fuel oil
- e. residual fuel oil
- f. jet fuel*
- g. petrochemicals

6. Unit cost of manufacturing

Discussion: The maximum gasoline pool is the most important variable in the refinery model. It gives the capacity of the manufacturing plant when operated at the optimum operating level. It depends on average octane requirements and on past expenditures for expansion, modernization and research.

The operating level is expressed as a fraction of optimum level. The actual level depends on the amount and quality of products requested, but cannot exceed 1.20.

The quantities of each product manufactured are given each quarter. These may differ from quantities requested for a number of reasons. The usual reason for any difference is that the premium requested is beyond the capacity of the facilities. More regular gasoline than requested may be produced in order to meet the premium request.

The unit cost of manufacturing depends on operating level, on the ratio of premium or regular, on octane level, on ratio of petrochemicals to other products, and on past expenditures for research and modernization. The result of capital expenditures is not immediate but several quarters must elapse before the full effect is achieved.

Crude storage capacity is increased by capital expenditures for expansion. When crude prices are low it may be desirable to purchase in excess of needs, provided crude storage facilities are adequate. Crude inventory can be controlled by requesting larger or smaller runs to refinery than total of manufactured products, using experience to estimate the crude required per barrel of gasoline. The ratio of crude to gasoline is called the inverse yield coefficient. This coefficient is initially of the order of 1.8.

It may not be possible to manufacture the quantities of products requested. It is important to accommodate requests for premium and regular gasoline to the maximum gasoline pool if possible because operation at levels either in excess or smaller than optimum cause an increase in unit processing cost.

* New products additions from previous versions

* New products additions from previous versions

C. Marketing

Required Decisions:

- | | |
|------------|--------------------------------------|
| Annual: | 1. Total Marketing Budget |
| Quarterly: | 1. Tank wagon prices of each product |
| | 2. Discounts in each market |
| | 3. Transfer prices |
| | 4. Advertising expense |

Information from Computer:

- | | |
|----|-------------------------------------------------|
| 1. | Inventory |
| | a. premium |
| | b. regular |
| | c. unleaded |
| | d. distillate |
| | e. residual |
| | f. jet fuel |
| | g. petrochemicals |
| 2. | Total product storage capacity |
| 3. | Unit costs of marketing and transportation |
| 4. | Sales of each product in each market in dollars |
| 5. | Total sales of each product in barrels |

An inventory of each product is given as well as total product storage capacity. If there is an excess of products over sales and storage capacity, this excess is disposed of by distress sales at a price which is below cost.

The company has no direct control over transportation costs, but marketing unit costs are affected by capital expenditures, advertising, and research.

The dollar sales and quantities of each product in each market are reported quarterly. These sales are determined by relative price, advertising, research, capital, previous market share, industry demand, and availability of the product. The demand for gasoline and fuel oil is highly seasonal.

The annual decisions required are total marketing budget and that part to be used for capital investment. This investment is in retail outlets, bulk outlets, product storage, etc. The remainder of the budget is used for operating expenses, including advertising.

Each quarter it is necessary to set tank wagon prices for each product, and set discounts allowed in each market. It will be seen from the decision sheets that some products are not marketed in all markets. Price, relative to competitors, has a strong effect on sales, but is not the only factor.

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Transfer prices are used to compute an internal dollar value for refined products. They are used in determining relative net income for each division of the company.

Advertising is an important decision and has a major impact on the determination company market shares. The effect of advertising lasts for more than one quarter.

D. Administration

Required Input Decisions:

- | | | |
|---------|----|----------------------------------------|
| Annual: | 1. | Total Administrative Budget |
| | 2. | Total research expenditures |
| | 3. | Dividends declared |
| | 4. | New capital from issue of common stock |
| | 5. | Size of long term bank loan |
| | 6. | Length of loan in years |

Computer Generated Output:

- | | |
|----|---------------------------------------------------|
| 1. | Consolidated State of Income |
| 2. | Consolidated Balance Sheet |
| 3. | Funds available for reinvestment Income per share |

The Consolidated Statement of Income shows aggregate company totals for each of the accounts listed. Negative figures indicate loss, and when these are present, the federal income tax is zero. The losses are carried over into future quarters for tax relief.

The Consolidated Balance Sheet shows company totals, not broken down by departments. When the notes payable account is not zero, this means that cash on hand was not sufficient for operating costs and a 90 day note was negotiated. Since these notes are at relatively high interest, they should be avoided. Increases in the long-term debt due within one year indicate that new loans have been negotiated during the previous quarter.

The total administrative budget includes provision for current liabilities, research and development expenses, administrative expenses (2% to 4% of gross income), and administrative capital (office buildings, etc.). The liabilities include debt due within one year, estimated income tax, and dividends payable during the year.

Research expenditures have important long term effects. In the Production Division they tend to increase the discovery coefficient for exploratory and development wells. In the Manufacturing Division they tend to decrease unit costs, increase yield, and increase petrochemical capacity. In the Marketing Division they tend to increase potential market share of all products, but especially of petrochemicals.

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Stock prices are affected by size and frequency of dividends and by net income per share. New capital may be obtained by issue of additional common stock. The amount of capital which can be raised in this manner is based on total assets, long-term debt, and past earnings record.

A company may raise additional capital by negotiating a long-term loan. The interest rate depends on length of loan, company earning during last four years, size of loan, and the current gross national investment. The loan period may vary from three to fifteen years. The total of outstanding debts should not exceed 30% of capital assets.