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MonopoLOGS
The Procurement Game
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MonopoLOGS

The Procurement Game¹

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Purpose:

MonopoLOGS has been developed in order to increase our understanding of the kinds of logistical decisions a product manager must make, and what criteria he should consider in making them. As a result MonopoLOGS has been designed to permit a wide range of decision-making, both in the kinds of decisions made, and in the latitude allowed the player in making them.

MonopoLOGS is formalized only in broad terms. It is planned that the basic parameters of the game will be varied in many ways. Thus, we shall be able to examine the product manager's reaction to the variations in these basic parameters.

MonopoLOGS I, the first game developed, will permit the product manager to make decisions in three broad areas: Procurement requirements, stockage distribution, and repair. (We use the term "repair" to mean the overhaul of spares and components, and reserve the term "maintenance" to mean the overhaul of the end item itself.) MonopoLOGS II will include the same three areas of decision-making, plus maintenance and programmed cannibalization.

The end result of the study of the MonopoLOGS games will be a set of decision-making rules which will represent an optimization, or perhaps a sub-optimization. MonopoLOGS itself represents merely a framework in which alternate decision-making rules, or optimizations, may be tested.

MonopoLOGS I and II will be played with one spare item, of recoverable

¹ The development of MonopoLOGS is the joint effort of Messrs. S. Enke, M. A. Geisler, W. Hamburger, and the present author.

type, and one type of applicable end-item. MonopoLOGS III will be a game with multiple spares for the same one type of applicable end-item.

It is intended that MonopoLOGS, in the beginning will cover comprehensively, the range of decisions applicable to an end-item, while retaining a simplicity of operation. In the future, it is expected that the game will develop, not in the direction of increased comprehensiveness, since a large degree of comprehensiveness, it is hoped, has been achieved at the outset; but rather in the direction of increased complexity. We expect the greatest increase in complexity will develop in the area of decision-making rules, as they move from simple rules of thumb to complex optimizing formulae. At some point in the development of the game, it will be desirable to move the game onto an electronic computer.

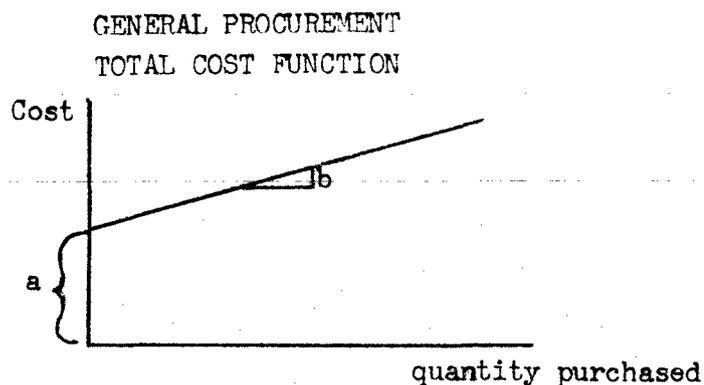
MonopoLOGS I

In MonopoLOGS I, the player will be permitted a broad range of decision-making in the areas of procurement requirements, stockage distribution, and repairs. Let us describe these areas successively in more detail.

1. Procurement Requirements Decisions.

The product manager (or player) will be permitted to buy as much of the spare as often as he wants. He will be able to choose between two types of procurement - routine and expedite.

For each purchase, the player will pay two kinds of charges, a fixed charge for procurement, which will represent the costs of contracting, and the production set-up costs of the manufacturer; and a cost which will be proportional to the number of items procured. In other words, the player is faced with an $a + bx$ type of procurement cost function:



in which a is the fixed element and b is the variable element. Both a and b will be higher for an expedited procurement than for a routine procurement, and the lead time, or time between the procurement decision and the availability of the spares procured, will be shorter for the expedited procurement.

When the airplane is no longer in production, both routine and expedite a and b costs will rise, and the procurement lead times will be greater.

All procurement lead times and costs will be considered variable for the MonopLOGS game, that is, they may vary from game to game. However, they will be fixed during the play of any one game, and will be known to the player.

The a term in procurement cost, representing the set-up costs, will be a useful tool for representing various procurement environments. If a is set high, it will tend to cause a life-of-type procurement policy. If a is set very low, it will tend to cause a short procurement cycle. It is most likely that a will be set at or near zero while the airplane is in production, and that it will rise a varying amount when production of the aircraft ends.

The manager will be able to cancel a procurement. He will be refunded none of the a procurement cost but will be returned his b costs prorated over the procurement lead time applicable to the procurement. In other words, if the applicable lead time is six months, and cancellation occurs after four

months, he will be returned two-sixths of his b costs (or will be charged the a costs plus four-sixths of the b costs).

A holding cost will be assessed against each item in the system, independent of its location. This holding cost may be assessed differentially against serviceables and reparable; there will be no assessment against condemned items.

2. Stockage Distribution Decisions

The players may move their stock of materiel freely from location to location. Monopologs I will be played with one depot location and five base locations. The charge for moving an item from one location to another will be independent of the locations, but will vary with the mode of transportation chosen. The player may choose between a routine shipment and an expedited shipment. The cost for moving an item under each mode of transportation will be proportional to the number of items moved; there will be one unit transportation charge for a routine shipment and another unit transportation charge for an expedited shipment. Monopologs I will be played with a fixed transportation pipeline of one month routine and zero months expedited. The unit transportation charges will be variable between games, but will be fixed and known for any one game.

The player will be assessed a base depletion penalty any time there is a demand for the item at a base at which no stock is available. He will be charged a higher system depletion penalty for each month of system depletion if a base depletion occurs, and there is no stock available to relieve the depletion anywhere in the system; or if there is stock available which the manager decides not to use for this purpose. The depletion penalties will be variable from game to game, but will be fixed and known to the players for any one game.

The base depletion penalty will be assessed per unit of base depletion. The system depletion penalty will be assessed per unit of system depletion and will be multiplied by the number of months during which the system depletion lasts.

Since MonopoLOGS deals with recoverable-type items, each demand at base level is really an exchange of a serviceable for a repairable item. For each demand a determination will be made whether the item exchanged is condemned, base repairable, or depot repairable. If the item is determined to be base repairable, no system depletion can occur, since the item will be considered to be serviceable within the month. A base depletion penalty will be charged in this case, however, if no item is available at the base when the exchange of the serviceable for the base repairable occurs.

3. The Repair Decisions

As depot repairables are generated at bases, the product manager may choose to leave them at the bases or to ship them to the depot. He may allow them to accumulate at the depot or may repair them. If he decides to repair them, he may choose between two kinds of repair, routine and expedite. Each type of repair will have a fixed element of cost, a , and a variable element of cost, b . Both a and b will be higher and the repair lead time will be shorter for the expedited repair. All repair costs and lead times will be variables of the game but will be fixed and known to the players for any one game. There will be no charge for performing base-level repair.

4. Mechanics of MonopoLOGS I

The object of the game will be to spend the least amount of money over the total play of the game.

MonopoLOGS I will be played in monthly time periods, and will simulate the total lifetime of an end item. The players will be given the lifetime

program of the aircraft, in terms of base-months, with a fixed number of aircraft assumed to be on the base. This program will represent the phase-in and phase-out of the aircraft in discrete units of the base-month. In other words, the aircraft will be phased in at one base, and then at two bases, until all five bases in the game are in operation. The phase-out will occur in the same discrete units. It will be assumed that a base is either in full operation, or is not in operation at all, and that the scale of operation will be identical for any two bases that are in operation. The program may be changed during the play of a game.

The demand pattern on each base will follow a Poisson distribution. The mean of this distribution will vary from game to game, but will be fixed during the play of any one game. The mean of the distribution will be unknown to the players of the game; it will be selected at random from a range of 0.1 to 5.0 per base-month at the beginning of the game, with each tenth bearing an equal probability. The players will have to estimate the mean being used from the demands as they develop.

For each time period in the game, a random draw will be made for each base in operation. This draw will determine the number of exchanges. If a table of random numbers is used for the draw, one or more of the digits will be used to determine the condition (that is, base reparable, depot reparable, or condemned) of the exchanged items.

The probabilities determining the condition of the items will be known to the players only within a range. The actual probabilities to be used for the determination of condition will be drawn at the beginning of the game, and will remain fixed for the game, although not known to the players.

There will be an attrition rate per base-month for each game. This rate, representing the gains of depot reparable from attrited aircraft, will be

known to the players as a range, but will be determined for the game at the beginning of play. The attritions will be determined as a random draw.

If more than one base is in operation, the random draws will be performed for one base at a time. If a base depletion occurs at a base, and an item is available elsewhere in the system, the player will have to commit himself to a shipment decision before the random draw on the next base occurs, if he is to avoid a system depletion.

5. Summary of Costs and Lead-Times in MonopoLOGS I

<u>a. Costs</u>	<u>Form of Function</u>
1. <u>Procurement</u> , plane in production, routine	a + bx
2. expedite	a + bx
3. plane out of production, routine	a + bx
4. expedite	a + bx
5. <u>Repair</u> , routine	a + bx
6. expedite	a + bx
7. <u>Transportation</u> , routine	bx
8. expedite	bx
9. <u>Holding Costs</u> , serviceable	btx
10. reparable	btx
11. <u>Depletions</u> , base	bx
12. system	btx

b. Lead-Times

There will be individual lead-times established for each of the first eight cost elements listed above.

MonopoLOGS II and III

In MonopoLOGS II, the product manager will be allowed to vary his procurement of whole aircraft. In addition, he will be able to purchase a

variable amount of maintenance capacity. The main element he will gain by increasing his purchase of maintenance capacity will be a smaller aircraft overhaul lead-time, and thus, a lower AOCM (aircraft out of commission for maintenance) rate.

The depletion penalty will be redefined. The manager will have a fixed in-commission mission to accomplish, and any failure to meet his mission because of aircraft out of commission for either maintenance or parts will be a depletion. In MonopoLOGS I any failure to supply a part is scored a depletion.

In addition, the manager will be allowed to cannibalize his aircraft in order to support some of them with parts taken from others during the phase-out period.

MonopoLOGS III will be an extension of MonopoLOGS II through an expansion from one spare to multiple spares managed for the support of the single end-item aircraft.