GPSS Simulation of Inventory with Periodic Review

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Abstract— The objective of present work is to model and simulate a inventory with periodic review using GPSS simulation tool. To achieve this task the problem statement is prepared to build the model and programmed using GPSS codes. Finally they are executed to analyze and interpret results-general data and statistics-that explains the behavior of the system.

Key words: Mathematical Modeling; Statistics; Case Study Protocols

I. Introduction

Programming discrete simulation models can be successfully accomplished using general purpose programming languages, such as Java or C++, or specialized languages like General Purpose Simulation System (GPSS) or Simula. While the former are known by any programmer, the latter introduce entities and processes in a higher abstraction level as well as a set of analysis tools to obtain data from simulated models. Thus, simulation languages greatly facilitate the development and execution of simulations of complex real-world systems. Most general purpose programming languages are designed around a set of instructions that control the execution of an algorithm: sequences, iterations and conditions are organized in objects, routines and subroutines. According to this simplification of programming languages, learning to build programs requires understanding what basic routines do and how they can be combined to deliver a recipe for the computer to execute. The behavior of a system as it evolves over time is usually studied by developing a simulation model. This model usually takes the form of a set of assumptions concerning the operation of the system and, once developed and validated, it can be used to investigate a wide variety of "What if?" questions about the real-world system.

Each simulation language generally possesses an orientation to real-world situations, which may be classified as event oriented or process-oriented. Simulation languages exist to make it easier to build models for analysis and to answer those what-if questions. Understanding the output of a simulation after it was executed is as important as programming the model. To learn an event-driven simulation approach, a few major concepts need to be incorporated: entities, events, queue theory, simulation times, etc. Thus, learning a simulation language requires understanding the syntax and semantics of the language to manage those new concepts. Unlike general programming languages, simulation languages are not built around basic or atomic instructions. Instead, they are based on high level sentences representing entities with abstract attributes and specific behavior. The combination of these sentences describes several system components and their interactions. Simulation languages are so powerful because they allow programmers to create complex models with very few lines of code, run those models and finally retrieve information – general data and statistics –Thus GPSS can be used to model any situation where transactions (entities, customers, units of traffic) are flowing through a system (e.g., a network of queues, with queues preceding scares resources). The block diagram is converted into block of statements, control statements are added, and the result is GPSS model.

II. Overview of GPSS

General-Purpose Simulation System(GPSS) is a process-oriented simulation language for modeling discrete systems. It uses a block-structuring notation to build models. These provide a set of standard blocks that provides the control and operations for transactions (entities). A model is translated into a GPSS program by the selection of blocks to represent the model's components and the linkage of them into a block diagram defining the logical structures of the system. GPSS interprets and executes the block diagram defined by the user, thereby providing the simulation. This interpretation is slow and, therefore, the language cannot be used to solve large problem.

III. Problem Statement

A finished product inventory is controlled by means of a weekly periodic review system. The initial stock is 1000 units. The daily demand varies between 40 and 63 units with equal probability. The target inventory is 1000 units, that is, the order is placed for the difference between the current stock and 1000 units. If the current stock is 800 or more, no order is placed for that week. The company operates a five-day week. The lead time for delivery of an order is one week. Simulate the inventory system for 200 days and determines if any stock outs occur.

The graphical representation of the basic economic inventory quantity model that gives the visual representation of the problem statement. Generally, the mathematical equation for total cost is given by

$$T = \frac{c_0 a}{Q} + \frac{hQ}{2} + c.a$$

To minimize total cost T, the second derivative of above equation leads to the value of Q that gives the minimum value of T

$$Q = \frac{\sqrt{2ac_0}}{\sqrt{h}}$$

Where,
Q= quantity which is ordered each time
a= rate of depletion of inventor
c_0=setup cost involved per order
h=holding cost per unit per unit of time held in inventory
T= total cost per unit time
c= cost of purchase of one unit

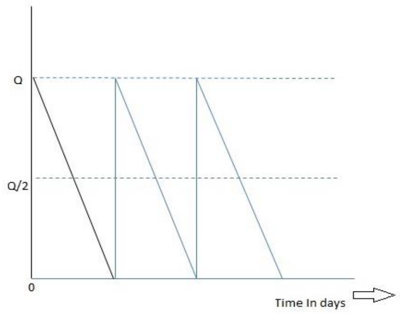

Fig. 1: Diagram of inventory level as a function of time for Economic Order quantity(EOQ) Model

IV. DESCRIPTION OF MODEL FUNCTION

Unlike general purpose programming languages, GPSS allows many Transactions to exist at different places in the simulation at any one time. In this model, Transactions are created at each of three GENERATE Blocks, creating three types of Transactions. In the top segment, a Transaction is introduced every 5 business days to review the inventory and reorder, if necessary. After 5 days the order is received and incorporated into the inventory. In the middle segment Transactions represent the daily demand. They cause items to be removed from inventory if the demand can be filled. Before the demand is been satisfied, the stock level is tabulated in the Table Stock. The single Transaction created in the last segment sets the initial inventory to 1000 items. This Transaction is given a high priority to ensure that it becomes the first Active Transaction. Time units are in days. The current content of the Storage Entity named Stock represents the current inventory level. This value is available as the SNA Stock. The Table named Stock accumulates a histogram of daily inventory levels. The named values Target and Reorder represent the two most important parameters of this scheme. Target sets the target stock level and Reorder sets the stock level which triggers a reorder. By using named values, we can easily change these parameters to explore alternate designs. The function of each General Purpose Simulation systems(GPPS) are as follows

Symbols	Description
A, B, Transfer	Causes a transfer to location C with probability A, and location B with probability 1-A
A, X, B, TEST	Causes a transfer to location C if A is not related to B according to operator X
Generate A,B,C,D,E,F,G	Creates transactions as prescribed by the operands A, B, C, D, E, F, and G
TERMINATE A	Destroys the arriving transactions and reduces the termination counter by A
ADVANCE A,B	Advances simulated time as prescribed by operands A and B
SEIZE A	Causes transaction to await and capture facility A
RELEASE A	Frees facility A
ENTER A	Causes transactions to await and capture B units of storage A
LEAVE A	Frees B units of storage A
QUEUE A	Increments the number in Queue A by B units
DEPART A	Decrement the number in Queue A by B units
A B C ASSIGN	Assigns the value specified as B with modifier C to parameter number A of the transaction
SAVE VALUE A B C	Assigns the current clock time to parameter number A of the transaction

Table 1: GPPS Block and its description

V. ANALYSIS

Our system was successful in preventing outages as seen in the value of the number of stockouts. The Max Stock shows the most items ever in inventory during the simulation. It appears to be higher than one might expect. The histogram of daily stock level is easily available. Notice, that the average stock level is 785.45 for a target level of 800. This represents money tied up in inventory, and is a measure of the cost of the system. Now, using a Custom Command to change the Target and Reorder levels to 600 and the histogram is modified as follows.

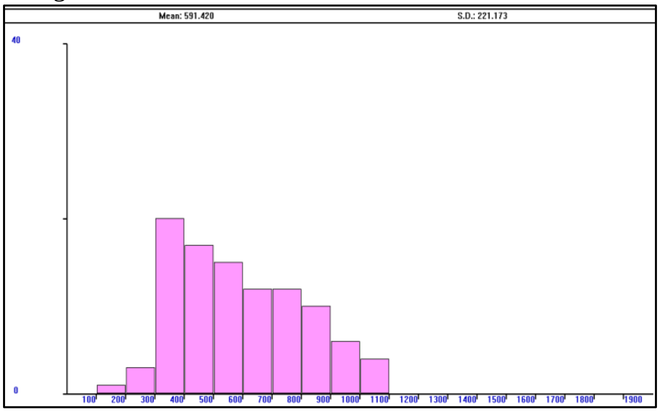

Fig. 1: Daily stock level for target value 600

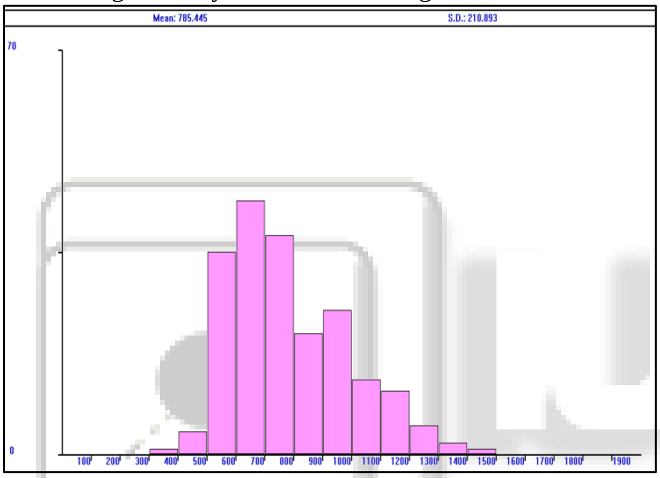

Fig. 2: Daily stock level for target value of 800

VI. CONCLUSIONS

The problem statement for inventory with periodic review was framed and analyzed by using GPPS simulation tool. The result analysis shows the average stock level was lower at 591.420. From our preliminary results, it looks like this is a sufficient, but less costly design. At the end, the application focuses on two key stages of modeling and simulation learning: model building and simulation run.

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