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ON ESTIMATING LOT SIZE FOR A VARIABLE LIFETIME STOCK ITEMS

(A SIMULATION MODEL)

By: W.A.M. EL-SHAFEI

A.H. ABD EL RAZEK

OPERATIONS RESEARCH GROUP.

CAIRO
3, MOHAMED MAZHAR - ZAMALEK

"The Authors would appreciate receiving any inquiries or suggestions. Any attempt for case studies is welcomed. For any inquires please mention classification number (ELT/101684).

ON ESTIMATING LOT SIZE FOR A VARIABLE LIFETIME STOCK ITEMS.

PROBLEM: Suppose that we want to estimate the number of micrometers to be kept in stock to fullfil inspection needs for a period of five years, assuming:

- We always need 12 micrometers in simultaneous operation
- Lifetime of micrometers is not fixed, the probable lives of the items are based on past experience are as follows:

TIME (MONTHS)	PER CENT OF MICROMETERS THAT WILL WEAK OUT
12	5
15	10
18	20
21	25
24	30
27	5
30	5

PROCEEDURE OF SOLUTION:

Since we haven't got exact data about the life of each micrometer individualy, we need to simulate the situation of working micrometers (concerning life) during the five year period.

We have to notice that on estimating the lives, each tabulated life has to be weighed according to its per cent of

existence. Choice of lives for micrometers has to be at random.

On choosing the life at random and bearing in mind that twelve micrometers have always to be simultanuously used, we can get an approximate value for the needed number.

STEPS OF SOLUTION:

(1) Write the given table in more detail, a line for each 5%, as follows:

TABLE II

SERIAL NUMBER	LIFE IN MONTH
1	12
2	15
3	15
4	18
5	18
6	18
7	18
8	21
9	21
10	21
11	21
12	21
13	24
14	24
15	24
16	24
17	24
18	24
19	27
20	30

(2) Starting with twelve micrometers, to determine their lives we have to choose AT RANDOM twelve different lives from table II

How Is This Done?

We refer to the TABLE OF RANDOM NUMBERS* (two digits tables) and read twelve numbers (Skiping numbers exceeding 20). Obtained numbers will indicate serial numbers in table II. Randomly selected lives are lives corresponding to those numbers. We obtain the simulated life of the first group.

Ex. x Refering to tables, the following numbers are read:
31, 15, 7, 3, 17, 24, 12, 22, 27, 29, 14,
23, 11, 21, 10, 5, 2, 7, 1, 16, 8, 4, 18, 9, 20,
26, 13, 6, 19, 25, 26, 30

x Numbers to be taken are:
15, 7, 3, 17, 12, 14, 11, 10, 5, 2, 1, 16

x Conesponding Lives are (Refer to TABLE II)
24, 18, 15, 24, 21, 24, 21, 21, 18, 15, 12, 24

(Those Figures Constitute 2nd column in TABLE V)

Estimated lives are within a maximum range of 24 months, this means that we still need more micrometers

(3) For the next twelve micrometers, the same proceedure can be repeated by choosing another group of RANDOM NUMBERS from tables and figure out corresponding lives.

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* Please Refer To: TABLES OF RANDOM NUMBERS (TWO DIGITS TABLES)
By W.A.M.N. EL-SHAFEI
or any other Random Numbers Tables

- We go back to table II to find corresponding Lives. Obtained Figures Constitute 3rd column in TABLE V

Examining 2nd and 3rd columns of table V, we notice that the sum of estimated lives in individual cases does not sum up to 60 See TABLE VI

We still need more micrometers.

MICROMETERS	MONTH WHEN UNIT WEARS OUT			
	1	2	3	4
1	24	21	12	21
2	18	21	24	
3	15	18	21	24
4	24	15	18	21
5	21	12	24	21
6	24	24	21	
7	21	21	30	
8	21	18	24	
9	18	24	18	
10	15	21	27	
11	12	30	24	
12	24	24	18	

TABLE V

MICROMETERS	CUMULATIVE LIVES			
	1	2	3	4
1	24	45	57	78
2	18	39	63	
3	15	33	54	78
4	24	39	57	78
5	21	33	57	78
6	24	48	69	
7	21	42	72	
8	21	39	73	
9	18	42	60	
10	15	36	63	
11	12	42	66	
12	24	48	66	

TABLE VI

(4) For the third group of micrometers, estimated lives are also to be chosen at random.

To select a random start, refer to the group of numbers obtained in (1) and take the second number (the first one being chosen for the second group). This number is found to be 11

- We go back to TABLE III and find the number corresponding to 11 to be the start for our selection

From table III, this number is 1

Serial Numbers For New Selection	1	16	8	4	18	9	20	13	6	19	15	7
Estimated Lives	12	24	21	18	24	21	30	24	18	27	24	18

TABLE IV (b)

- As for second group, we go back to table II to find corresponding Lives. Obtained figures constitute 4th column in TABLE V

From TABLE VI we notice that using three groups of micrometers doesen't add up to 60 months of operation in all the cases. In those cases, with estimated lives less than 60, we need individual micrometers to complete 60 months operation time. Inspection of table VI reveals that we still need four more micaometers

(5) For the needed four micrometers, same proceedure is to be followed as before,

Estimated Lives are as shown below

Serail Number For New Selection	12	14	11	10
Estimated Lives	21	24	21	21

TABLE IV(c)

- As before, we go back to table II to find corresponding lives. Obtained figures constitute 5th column in TABLE V

Reviewing TABLE VI shows that three complete micrometer sets + 4 micrometers are enough to guarantee continuous operation with twelve micrometers working simultanuously for the whole period of sixty months.

SIMULATED NUMBER OF MICROMETERS = 3 x 12 + 4

= 40

CONCLUSION:

This simulation model made it possible to forecast the demand of micrometers in a simple way. Without simulation technique, we would have used rather complicated mathematical formulee.

Using RANDOM SELECTION avoids any bias in vanious estimations.

Using RANDOM STARTS avoid any tendency for special patterns or sequences of Lives.

PROGRAMMING FOR THE IBM-1620:

The type of data in this problem permits hand calculations without need for a computer. If in the same problem (or a similar one) we have:

- Different probable lives (based on past experience) with smaller percentages and smaller Fimes.
- More items in simultanuous operation (30 instead of 12)
- Longer period of stock holding (160 time units instead of 60)
- More than one RANDOM PHENOMENA is affecting decision making.

In such a case hand calculations might be ever so tedious and troublesome, then our fiend (THE COMPUTER) steps in to solve this dilemma.

HOW IS SUCH A PROBLEM PROGRAMMED?

The same steps followed in hand made calculations are here followed, with the following remarks:

How could we make the computer select at random?:

A Special SUBROUTINE FOR RANDOM NUMBERS GENERATION* was set up to generate random numbers. This step is exactly the same as step (2) in previous calculations.

Numbers shown in step (2) are some results obtained from this subroutine.

Another SUBROUTINE (of different cyclic Length) was set up for SELECTING THE START AT RANDOM (as in step (3))

PROGRAM RESTRICTIONS:

Restricted by the IBM - 1620 Limited Storage capacity, the program was generalized but within certain restrictions:

- Maximum No. of items to be in simultanuous operation = 20
- No. of complete sets is to be within 30 set (allowed till 36)
- Maximum stock Holding period is to be determined in proportion to data for probable life and expected no. of sets.

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*Please Refer To: A NEW METHOD FOR RANDOM NUMBERS GENERATION"
By W.A.M.N. EL-SHAFEI

For the flexibility of the program we made it possible to read values of:

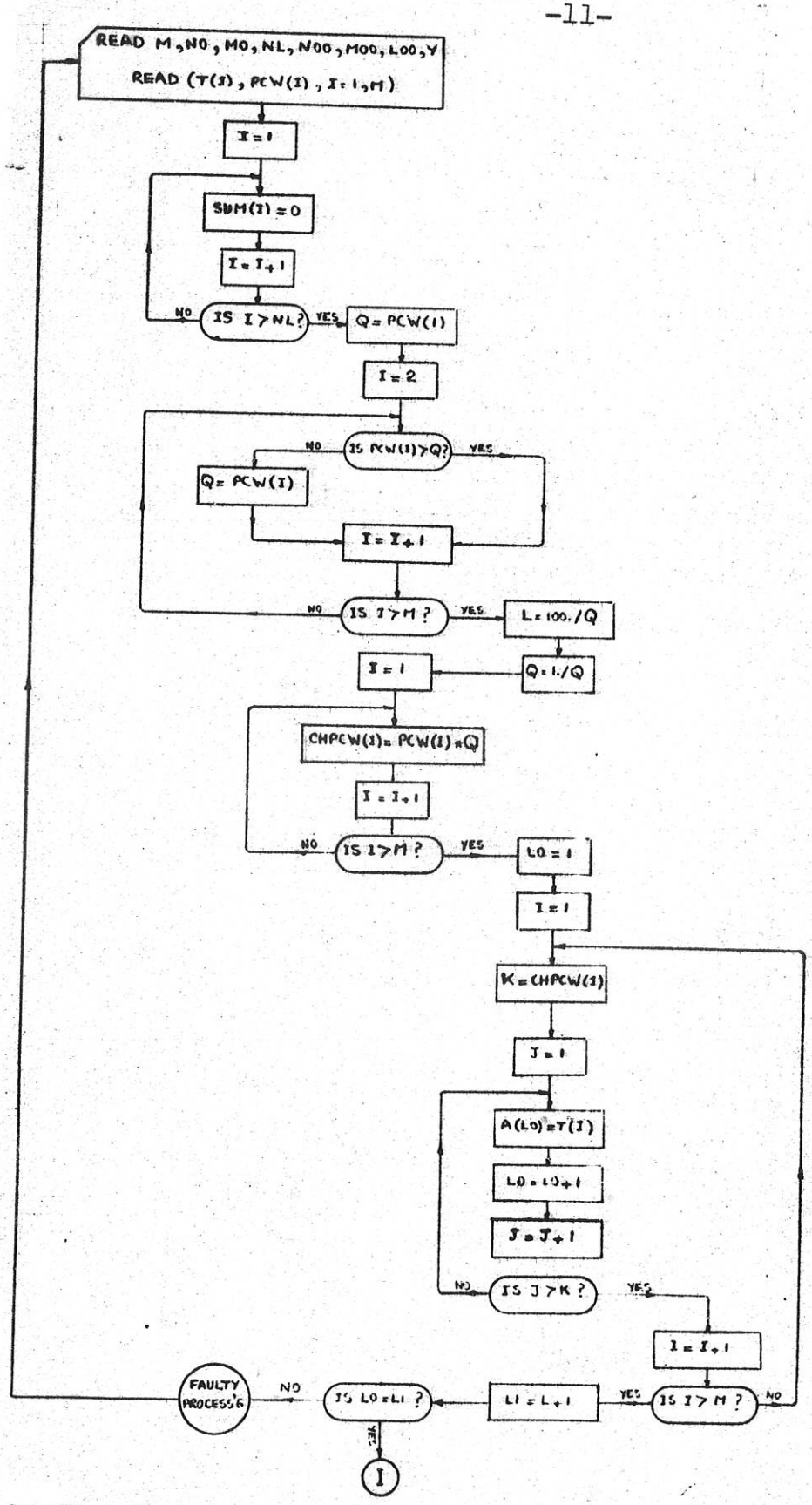
1) No. of items to be in simultanuous operation

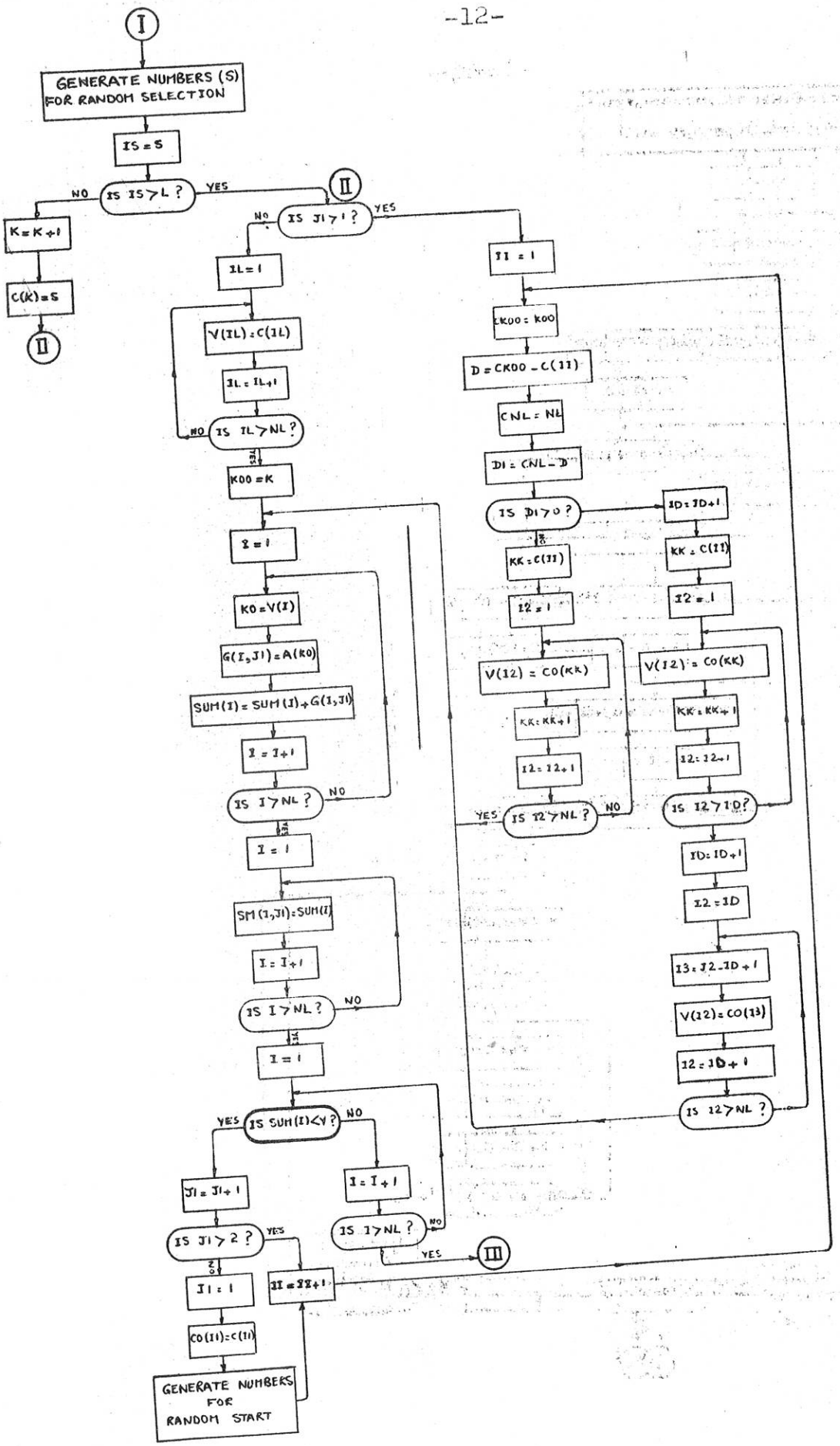
2) Stock holding period

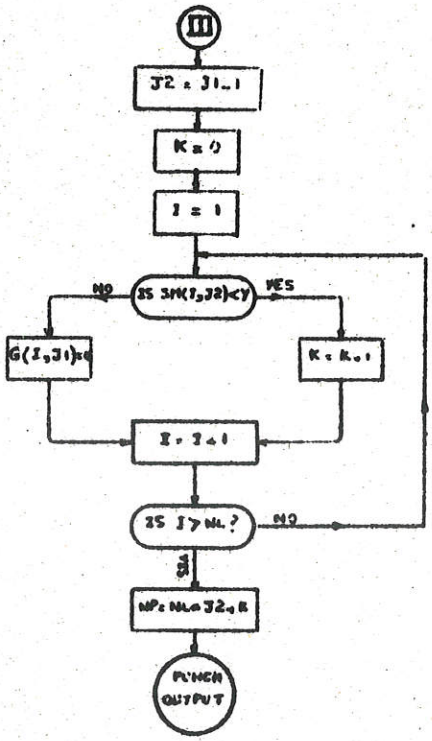
In the following pages the FLOW-CHART is shown

The PROGRAM was coded in FORTRAN II

PUNNING TIME: 15 Minutes


READ M, NO, MO, NL, N00, M00, L00, Y
READ (T(I), PCW(I), I=1,M)
I=1
SUM(I)=0
I=I+1
IS I>NL?
NO
YES
Q=PCW(I)
I=2
IS PCW(I)>Q?
NO
YES
Q=PCW(I)
I=I+1
IS I>M?
NO
YES
L=100./Q
Q=1./Q
I=1
CHPCW(I)=PCW(I)*Q
I=I+1
IS I>M?
NO
YES
LO=1
I=1
K=CHPCW(I)
J=1
A(LO)=T(I)
LO=LO+1
J=J+1
IS J>K?
NO
YES
I=I+1
IS I>M?
NO
YES
LI=L+1
IS LO=LI?
NO
FAULTY PROCESSING
YES
I


I
GENERATE NUMBERS (S) FOR RANDOM SELECTION
IS = S
IS IS > L ?
NO
YES
K = K + 1
C(K) = S
II
IS JI > 1 ?
NO
YES
IL = 1
V(IL) = C(IL)
IL = IL + 1
IS IL > NL ?
NO
YES
K00 = K
I = 1
K0 = V(I)
G(I, JI) = A(K0)
SUM(I) = SUM(I) + G(I, JI)
I = I + 1
IS I > NL ?
NO
YES
I = 1
SM(I, JI) = SUM(I)
I = I + 1
IS I > NL ?
NO
YES
I = 1
IS SUM(I) < Y ?
YES
NO
JI = JI + 1
IS JI > 2 ?
YES
NO
I1 = 1
CO(I1) = C(I1)
GENERATE NUMBERS FOR RANDOM START
I = I + 1
IS I > NL ?
NO
YES
III
II = II + 1
II = 1
CK00 = K00
D = CK00 - C(I1)
CNL = NL
DI = CNL - D
IS DI > 0 ?
YES
NO
KK = C(I1)
I2 = 1
V(I2) = CO(KK)
KK = KK + 1
I2 = I2 + 1
IS I2 > NL ?
YES
NO
ID = ID + 1
KK = C(I1)
I2 = 1
V(I2) = CO(KK)
KK = KK + 1
I2 = I2 + 1
IS I2 > ID ?
ID = ID + 1
I2 = ID
I3 = I2 - ID + 1
V(I2) = CO(I3)
I2 = ID + 1
IS I2 > NL ?


III
J2 = J1-1
K = 0
I = 1
IS SM(I,J2)<CY
NO
YES
G(I,J1)=0
K = K+1
I = I+1
IS I>NL?
NO
YES
WP=NL*32+K
PUNCH OUTPUT