A SITE VALIDATION OF GPSS AND SLAM II

By

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Scope and Method of Study: This study examines the computer simulations languages GPSS and SLAM II. A site validation of the PC version of SLAM II is performed. Results from twelve different models, each run in GPSS and in SLAM II, are compared. An analysis is made of the methods of pseudorandom number generation used in the two languages. GPSS and SLAM II normally distributed random number streams are subjected to a Chi-square test to confirm normality.

Findings and Conclusions: The differences in output between identical models run in GPSS, mainframe SLAM II and PC SLAM II could not be attributed to anything other than statistical variations caused by the use of different random number streams. Mainframe SLAM II used approximately four times as much CPU time to run models as did GPSS. The seed values used in setting the SLAM II IBM PC version pseudo-random number generator must be between -32768 and 32767.

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TABLE OF CONTENTS

I. INTRODUCTION

One of the best ways to gather data on an existing or proposed factory or store layout, assembly line, or other system is to model it. Models can provide detailed data on numerous key sections of the system, and can spot potential bottlenecks, or areas where resources may be over- or underutilized. It may also be impractical, or too costly or lengthy a process to observe the actual system in operation. For this reason several modelling computer languages are popular.

Two of these languages are GPSS and SLAM II. The goal of this report is to find out whether the mainframe versions of the two languages are compatible with each other and with the micro version of SLAM II. That is, when the same model is run in both languages, are the results similar?

Twelve different models are run, both in GPSS and in SLAM. The systems simulated require the use of most of the network modelling commands available in GPSS and SLAM. The results are compared in APPENDIX A. A discussion of the method of pseudorandom number generation used by GPSS and SLAM is included. The differences between the variability in the output from the two languages is compared to the variability due to the different random number

streams. Further, a Chi-square analysis of GPSS and SLAM normally distributed random number streams is made to determine how closely these streams approximate the normal curve.

The same format is followed throughout the report. GPSS and SLAM code and results immediately follow all text. The output may be consulted to further detail the written explanation and to confirm results.

II. PSEUDORANDOM NUMBER GENERATION

Both GPSS and SLAM use deterministic means to generate streams of random numbers on digital computers. The two most popular methods of generating uniform random numbers are the multiplicative congruential method described by the recurrence formula

$$X_{i+1} = AX_i \text{ (modulo M)}$$

and the mixed congruential method described by

$$X_{i+1} = (AX_i + C) \text{(modulo M)}$$

A, M, and C are constants chosen to yield a long period of unrecurring numbers and other desirable statistical properties in the sequence. The modulo product and sum in the above formulas are obtained by division of AX_i, or $AX_i + C$, by M, and taking the remainder as the next random number. As each random number is obtained it may be normalized to the unit interval by dividing by M. The numbers obtained will approximate a uniform distribution between 0 and 1 very closely. However, several authors report that the mixed generator has not produced satisfactory results.[1]

A maximum period of 2^{B-2} before recycling occurs is obtained on a computer with B bits/word for the multiplicative congruential generator $X_{i+1} = AX_i \pmod{M}$ when

$M = 2^b$;

A = + or - 3 + 8K or 1 + 4K where K is a positive integer;

and

X_0 is odd.

If X_0 is not odd, less than a full period will be obtained.[2] There are several other considerations for choosing a value of A yielding good statistical properties which will not be discussed in this paper.[3]

A full period of 2^B before recycling is obtained on a computer with B bits/word for the mixed congruential generator $X_{i+1} = (AX_i + C) \pmod{M}$ when

$M = 2^B$;

C is relatively prime to M;

and

$A = 1 \pmod 4$ or A = 1 + 4K, where K is any positive integer.

GPSS uses a multiplicative congruential generator, and has eight different random number streams. Unless the user selects otherwise, the initial values of all seeds, X_0, are set to 37. Thus all eight generators will produce exactly the same sequence of numbers, although, depending upon how many times each generator is referenced, this will occur at different points along the sequence.[4]

SLAM uses a mixed congruential method to generate its random numbers. SLAM has 10 random number streams, all of which start with different seed values, the first of which is 4289564175.

On both SLAM and GPSS, the user has the option of reinitializing the streams between multiple runs of the same model. An easy way to obtain results using different random number streams is thus to rerun the model without resetting the generators.

A simple test is set up to check the hypothesis that the variation in results between a SLAM run and a GPSS run of an otherwise identical model can be explained by variation resulting in differences between the two random number streams. Although not a scientifically rigorous experiment, the results are interesting.

The total length of the run is selected as the statistic of interest. It is felt that this best represents the total effects of the random number generator, which is employed five separate times within the model selected. The model simulates a hospital clinic, and is also discussed in detail later in this report.

The model is first run using the standard seed values. This is exactly how all the other models to be compared were run. The GPSS result was 8465 minutes, the SLAM result 8621 minutes.

Both models are then run with four new seed values:

42895, 79416, 20049, and 63381.

GPSS simulation times are, respectively,

8554, 8374, 8395, and 8326.

SLAM simulation times are, respectively,

8621, 8422, 8403, and 8369.

It is interesting to note that SLAM seed values of:

428956417, 794161921, and 200496737

produce exactly the same first three respective SLAM results.

The sample estimate $\bar{Y}$ will be $t_{\alpha/2}$ standard errors of the mean on either side of the population mean μ with a specified level of risk α and a level of coincidence $1-\alpha$. It is necessary to use to use the t distribution to set the confidence intervals, since the population variance is unknown.

The sample means are:

$\bar{Y}_{GPSS} = 8412$ $\bar{Y}_{SLAM} = 8451$

The sample standard deviations are:

$S_{Y_{GPSS}} = 99$ $S_{Y_{SLAM}} = 114$

The standard errors of the mean are:

$S_{\bar{Y}_{GPSS}} = S_Y/\sqrt{n} = 99/\sqrt{4} = 49.5$

$S_{\bar{Y}_{SLAM}} = S_Y/\sqrt{n} = 114/\sqrt{4} = 57$

$t_{\alpha/2}$ for level $\alpha = 0.05$ and $n - 1 = 4 - 1 = 3$ degrees of freedom is 3.182. The half width of the interval is,

$d = t_{(0.025)} * S_{\bar{Y}}$. $d_{GPSS} = 157.5$, $d_{SLAM} = 181.4$.

The confidence interval limits are:

$L_{1_{GPSS}} = 8412 - 157.5 \cong 8255$ $L_{2_{GPSS}} \cong 8570$

$L_{1_{SLAM}} = 8451 - 181.4 \cong 8270$ $L_{2_{SLAM}} \cong 8632$

We can be 95% confident that the population mean for length of system run time is bounded by the limits $[8255,8570]_{GPSS}$ and $[8270,8632]_{SLAM}$. The range is large due to the small sample size and large amount of sampling variability.

The interval within which one would expect system time values to fall is relatively large. There is also considerable overlap between the GPSS and SLAM intervals. Note that for this particular test case, the values produced by the first random number seed fall at the upper

limits of the normal interval, for both GPSS and SLAM. This coincidence is expected, due to the similar nature of the two random number generators.

The standard GPSS seed produces a result of 8465 minutes, well within the above intervals for either GPSS or SLAM. The standard SLAM seed (the first SLAM seed used here) produces a result of 8621 minutes, which is beyond the GPSS interval. From the sample size used, however, it cannot be concluded that the differences in the results between GPSS and SLAM are not a function of different random number streams. This means that the differences between the GPSS and SLAM output cannot be attributed to the way the GPSS and SLAM compilers run code, or to any other reasons.

III. A COMPARISON OF SLAM VERSIONS FOR THE IBM MAINFRAME AND PC

The mainframe version of SLAM for the IBM 3081 D is compared to the version for the IBM PC. Several very disconcerting inconsistencies appear to come to light for both versions. The same four random number seeds are used for the PC as for the mainframe, namely:

42895, 79416, 20049, and 63381.

The PC SLAM Echo Report records the seed values as:

22641, 13881, 20049, and 2155.

Furthermore, the following seed value, 794161987, which reset the stream value for a new run on a SLAM program, produces an Echo Report value of 794161921 on the IBM 3081 D mainframe. This

particular seed value is the default seed used for the first SLAM generator. Notice that the last two digits have changed. It seems that something is afoul with SLAM's ability to set seed values for the random number generator. Can these glaring discrepancies be resolved, or is there a fundamental problem with setting the seed value in SLAM?

The mainframe problem is probably due to limited decimal point accuracy. If the same number was inputted in double precision, it is not expected that there would be any error. In addition, as noted before, the default value for the first random number seed (794161987) and the seed value 79416 both produce identical output. This would indicate that the generator is only sensitive to the first few digits of any given seed, so that even if a large seed gets changed in the compiler, this will probably not have any effect on the output.

```
20  SEEDS,794161987(1)/NO;
21  MONTR,SUMRY,,1000E+21,,;
22  SIMULATE;
```

RANDOM NUMBER STREAMS

STREAM NUMBER	SEED VALUE	REINITIALIZATION OF STREAM
1	794161921	NO
2	1954324947	NO
3	1145661099	NO
4	1835732737	NO
5	794161987	NO
6	1329531353	NO
7	200496737	NO
8	633816299	NO
9	1227678669	NO
10	654529758	NO

To understand what is happening on the IBM PC, it is necessary to know how the computer stores numbers. The PC is a 16 bit machine. This means that 16 bits are used to represent an integer number, where each bit is a binary character and can be either 0 or 1. The 16th bit is used to store information on whether the number is positive or negative. This leaves 15 bits to store the actual number. The computer can store any integer number from -2^{15} to $2^{15}-1$. The highest positive value is $2^{15}-1$ because counting actually starts with zero. The computer takes the ASCII value of the seed number and converts that to binary coded decimal (BCD), then converts the BCD value to binary, which can be understood in machine language.

When too large a value is used, such as 794161987, the number overflows the binary representation of the integer number which was inputted into the IBM PC. Since the range of integer values goes from -2^{15} to $2^{15}-1$, or -32768 to 32767, the computer can only store a number 32767 or smaller. When a larger value is entered the computer overflows the memory register, which is 16 bits.

What actually occurs next is rather complicated, but in layman's terms it may be thought of as the following. The computer subtracts a 16 bit word, or 2^{16} from the input value which is too large, then takes the absolute value of the result. If this value is less than 32767, the resulting value is used. Otherwise, this routine is repeated until the absolute value is less than 32767.

For example, consider the case where the seed value of 42895 is entered. The SLAM Echo Report subsequently lists the seed value as being 22641. This is because 42895 is greater than 32767, so the

computer subtracts 2^{16}. This yields -22641. Taking the absolute value, we get 22641, the seed value actually used. Following this discussion is a SLAM PC program which uses the default values of the mainframe program as seeds for the ten SLAM pseudorandom number generators. Notice how the seed values in the program are altered in the Echo Report. The computer is actually using the first 15 bits of the binary representation of the inputted seed values. As another example, the first seed, 633816299, equals $17643 + 2^{16} * 19342$. This means that the inputted number overflows the memory register 19342 times before a small enough value, 17643, is obtained. Notice that 17643 is the value listed in the Echo Report as being the first seed value.

The conclusion of this discussion is that Pritsker and Associates, Inc., which markets SLAM and PC SLAM, should point out that mainframe SLAM and PC SLAM are not 100% compatible. The SLAM II PC VERSION USER'S MANUAL states that "This microcomputer version of SLAM II is 100% compatible with the mainframe and minicomputer version."[6] This is not true. Specifically, integer values in the PC version may only range from -32768 to 32767.

IV. DIFFERENCES BETWEEN GPSS AND SLAM II

Perhaps the most important contrast between GPSS and SLAM concerns run time. For example, the previous GPSS run - one model run four time with different seeds - takes 2.09 seconds of CPU time at a total first shift cost of $0.87 on the IBM 3081 D. The same SLAM

program takes 6.79 seconds of CPU time at a cost of $2.60. This cost differential is typical of all the different models compared. GPSS consistently ran significantly faster. This costs could be a consideration for extensive models with longer runs.

GPSS has the advantage that user defined distributions can easily be incorporated within the GPSS framework. It has the disadvantage that only uniform distributions may be easily modeled. Normal, exponential and other distributions require a user written GPSS function, which is somewhat awkward. SLAM incorporates the necessary software to model many common distributions with simple programming statements. Conversely, SLAM requires a Fortran subroutine to model user defined distributions. Aside from the mess this causes with getting the proper JCL, and with the errors that can creep up from incorrect Fortran code, or improper dimension statements, linking the two languages can easily add up to 300% or more in extra CPU time.

GPSS, however, does not lend itself easily to Fortran subroutines, although they may be utilized. SLAM can accept Fortran subroutines without many complications and includes numerous Fortran functions and subroutines that may be called by the programmer. For this reason, SLAM is probably more versatile than GPSS in the types of problem which it can model.

Three common problems that can occur when using Fortran subroutines with SLAM are worthy of note. First, SLAM must be called as a subroutine or a user written Fortran main program. This allows dimensioning of the NSET/QSET by the user.

Second, it is crucial to understand the use of the NSET/QSET. The Fortran array QSET is in an unlabeled COMMON statement and is equivalenced to the labeled array NSET which has the same dimension. This allows both integer and real data to be stored within a single contiguous array storage area. These arrays are used by SLAM to store both event with their associated attributes and entities in files with their associated attributes.[7]

This means that the dimension of the arrays NSET/QSET determines the maximum number of entries which can be in the system at a given time. An entry refers to both events and entities which are stored in NSET/QSET arrays. The maximum number of entries (MNTRY) that can exist at one time is limited by the equation:

$$MNTRY \leq NNSET / (MATR + 4)$$

where

NNSET is the dimension of NSET/QSET, and

MATR is the maximum number of attributes per entry employed in the simulation model.

This governs the relationships within the SLAM Echo Report. There is an example of an Echo Report listing included with the output for the Department Store example, #50. The words allocated to the filing system equal MNTRY * (MATR + 4). In a typical NSET/QSET storage allocation, 390 words are allocated to Indexed List Tags. The remaining words are allocated to the Network or are available for Plots and Tables. Both, especially Plots and Tables, require a generous number of words (where the amount of available words equals the NSET/QSET dimension).[8]

This means that if a user dimensions the NSET/QSET first, and determines the maximum number of attributes from this dimension, they will most likely get an error, as well as a negative Plots and Tables word allocation. The NSET/QSET allocation when using Fortran subroutines, must be determined after the maximum number of entities that can exist at a given time. As a rule of thumb, if MATR equals 500, a safe NSET/QSET dimension is 5000.

Third, the sample main program listed on page 238 of Pritsker should be used to call SLAM, with separate Fortran subroutines following, before the SLAM code is included. Also, it is important to include the labeled COMMON statement SCOM1 in most subroutines. The values included usually need to be passed through. See the code and output for the Department Store program, #50, or the Pheasant Farm program in SLAM, both included later in this report, for examples.

As a final note, OSU currently has SLAM II version 2.1. A version 2.3 is available, which is claimed to have shorter run times.

V. ARE STREAMS OF NORMALLY DISTRIBUTED RANDOM NUMBERS CREATED IN GPSS AND SLAM II TRULY NORMAL: A CHI-SQUARE TEST

To test the GPSS and SLAM random number generators, as well as their functions for creating normal distributions, a Chi-square test of two distributions is used to check the null hypothesis that they are normal. The distributions checked come from the Department Store example, #50. Data is collected on check out times from the store for GPSS and SLAM for each entity in the system. The first distribution

checked is the GPSS distribution. It is felt that plausible values for and are 306 and 40, respectively, before observing the individual check out times $x_1,\ldots,x_{963}$.

To obtain the estimated cell probabilities $\pi_1(\hat{\mu},\hat{\sigma}),\ldots,\pi_{13}(\hat{\mu},\hat{\sigma})$, maximum likelihood estimates $\hat{\mu}$ and $\hat{\sigma}$ are first needed. The maximum likelihood estimator of $\hat{\sigma}$ is $[\Sigma(x_i-x)^2/n]^{1/2}$ (rather than s), so with s = 41.750,

$$\hat{\mu} = \bar{x} = 304.252,\ \hat{\sigma} = [\Sigma(x_i-x)^2/n]^{1/2} = [(n-1)s^2/n]^{1/2} =$$

$$= [(963-1)(41.750)^2/963]^{1/2} = 41.728$$

Each $\pi_i(\hat{\mu},\hat{\sigma})$ is then the probability that a normal random variable x with mean 304.252 and standard deviation 41.728 falls in the ith class interval (for GPSS). For example,

$$\pi_2(\hat{\mu},\hat{\sigma}) = P(190<x<210) = P(-2.74<z<-2.26)$$

$$F(b) - F(a) = \Phi(0.0119) - \Phi(0.0031) = 0.0088$$

so, $n\pi_2(\hat{\mu},\hat{\sigma}) = 963(0.0088) = 8.47$

where Z = (CELL LIMIT $-\hat{\mu}$)$/\hat{\sigma}$

$$\chi^2 = \sum_{\text{ALL CELLS}} (\text{OBSERVED} - \text{ESTIMATED})^2/\text{ESTIMATED}$$

with k = 13 cells and m = 2 parameters estimated,

$$\chi^2_{.05,k-1} = \chi^2_{.05,12} = 21.026$$

$$\chi^2_{.05,k-1-m} = \chi^2_{.05,10} = 18.307$$

Further calculations are included in Appendix B. Since $\chi^2 = 12.08_{GPSS} \leq 18.307$, and $\chi^2 = 12.28_{SLAM} \leq 18.307$, a normal distribution provides quite a good fit to the data.

It can not be concluded that either GPSS or SLAM is not capable of providing streams of random, normally distributed numbers.

VI. SUMMARY AND CONCLUSIONS

GPSS and SLAM II are both excellent modelling languages. Each is comparatively easy to learn, and both may be pictorially represented through flow diagrams. These graphical models may be translated into the respective input statements for direct computer processing.

The two languages have pseudorandom number generators which work quite well. The generator seed values must be between -32768 and 32767 for the PC version of SLAM. This is not mentioned in the user's manual. PC SLAM uses a mixed congruential random number generator of the form $X_{i+1} = (AX_i + C)(\text{mod } M)$, where $M = 2^B$. Since the IBM PC has 8 bits/word, B = 8. The mainframe uses a larger value for B, 32. If an identical model is run on both the mainframe and PC versions of SLAM, the results will not be identical due to the different pseudorandom number streams used.

GPSS and SLAM both have the capability of creating a flow of random, normally distributed entities with a user set means and standard deviations. With GPSS, it is necessary to define a function statement and interpolate between user inputted data points which define the normal or other curve. SLAM can handle several different distributions internally. The result is a closer approximation of the distribution than is possible with GPSS.

A sample of mainframe CPU time for 12 different models is compared. Both are run once in GPSS and once in SLAM. The result is that SLAM takes 393% more CPU time than GPSS. This indicates that

considerable funds might be saved through running large problems in GPSS, rather than SLAM. This sample is slightly biased because certain SLAM problems are run using Fortran subroutines, and the time to link the code is significant. In some instances it may have been possible to run the programs is SLAM only. Nonetheless, this bias is not large.

The ease of running Fortran subroutines makes SLAM a more versatile language than GPSS. SLAM is also conceptually easier to grasp, although this of course is a matter of opinion.

GPSS and SLAM II consistently give statistically similar results when identical models are run using both languages. A wide variety of models utilizing various features of the two languages is compared. No significant differences or biases are discovered in the results. Either language may be used with equal confidence for modelling.

The PC version of SLAM is also validated. As long as the limitations on integer number size are observed, mainframe SLAM models may be run on the PC and vice versa with no modifications to the SLAM code necessary. The results will be statistically similar, differing only due to the distinct pseudorandom number streams employed. The PC version may be used with the same confidence as mainframe SLAM.

ENDNOTES

[1]Randall D. Donahoo, Notes taken in ECEN 5783, OSU, Spring, 1985.

[2]A. Alan B. Pritsker, Introduction to Simulation and SLAM II, West Lafayette, Indiana, Systems Publishing Corporation, 1984, p. 59.

[3]Op. Cit., Randall D. Donahoo.

[4]Geoffrey Gordon, The Application of GPSS V to Discrete System Simulation, Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1975, p. 333-336.

[5]Op. Cit., A. Alan B. Pritsker, p. 39-40, 59.

[6]William R. Lilegdon and Jean J. O´Reilly, "SLAM II PC VERSION USER´S MANUAL," West Lafayette, Indiana: Pritsker and Associates, 1984, p. 1.

[7]Op. Cit., A. Alan B. Pritsker, p. 237.

[8]Op. Cit., A. Alan B. Pritsker, p. 273.

[9]Jay L. Devore, Probability and Statistics for Engineering and the Sciences, Monterey, California, Brooks/Cole Publishing Co., 1982, p. 537.

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APPENDICES

APPENDIX A
SLAM AND GPSS MODELS

HUNTING BIRDS #13

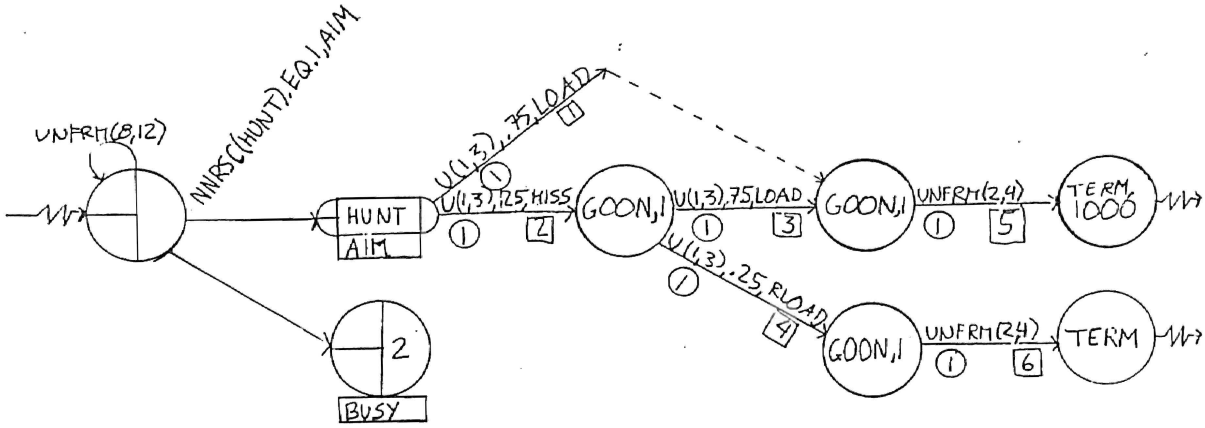
A hunter is hunting migratory birds in Jesup. She must remain in her present position until she has successfully killed 20 birds. It takes 2 + or - 1 seconds to fire the gun and 3 + or - 1 seconds to reload. The hunter is using a double-barreled shotgun, fires at most twice at each bird and reloads after firing at each bird. Birds pass over at a rate of one every 10 + or - 2 seconds and the hunter has a 75% success rate on each shot. How long does it take the hunter to kill 1000 birds?

ANALYSIS OF SLAM, PC SLAM, AND GPSS RUNS

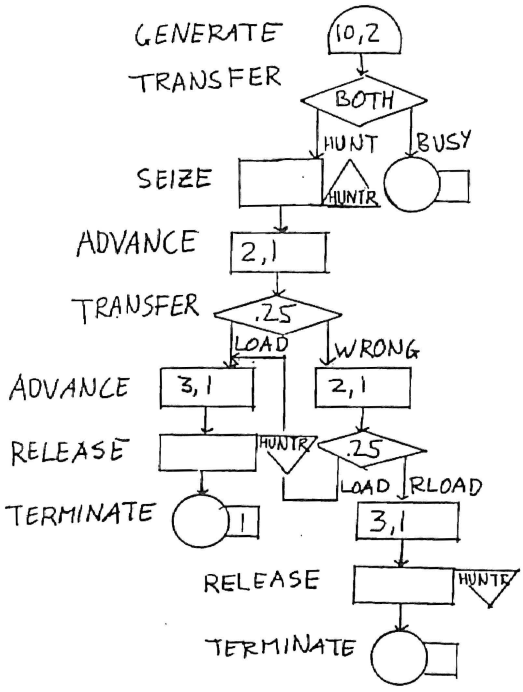
The two most important statistics of interest in this example are the length of time it took the hunter to kill the 1000 birds and the percentage of time the hunter was busy. The length of time is measured in SLAM by CURRENT TIME, which equals 10730 minutes for mainframe SLAM and 10710 for the PC version, and by the ABSOLUTE CLOCK in GPSS, which registers 10988 minutes. In SLAM, the average utilization of the hunter (the percentage of time the hunter was engaged in firing or reloading) is measured by AVERAGE UTILIZATION of resource HUNT, which is listed under the RESOURCE STATISTICS. This value is .5415, and .55 for PC SLAM. The corresponding GPSS value is found under the FACILITIES heading for the facility HUNTR. The average utilization during the total time was .534. The length of the simulation and the average time the hunter was busy are similar in both GPSS and SLAM. As demonstrated earlier, the variation in results can be attributed to differences in the streams of pseudorandom numbers used.

SLAM NETWORK DIAGRAM

HUNTING BIRDS #13



GPSS NETWORK DIAGRAM



```
                                              CPU     OMIN 02.06SEC
-------------------------------------------------------------------------
PROCESSOR TIME ---------0.00066 CPU HOURS @ $1,135.00 --------0.75
PROCESSOR STORAGE ------0.40284 K-BYTE HOURS @   $0.25 --------0.10
                                     TOTAL PROCESSOR COST -------$0.85
DISK EXCPS ------------------52 @  $0.36 PER 1000 ------------0.02
              I/O COST (EXCLUDING PRINTER/READER/PUNCH) -------$0.02

TOTAL COST (AFTER       $0.52    3RD SHIFT DISCOUNT) ---------$0.35
```

SLAM

```
GEN,BRADLEY,HUNTING BIRDS #13,5/30/85,1;
LIMITS,2,0,500;
NETWORK;
      RESOURCE/HUNT(1),1;
      CREATE,UNFRM(8,12);                  CREATE BIRDS
      ACT,,NNRSC(HUNT).EQ.1,AIM;
BUSY  QUEUE(2);
AIM   AWAIT(1),HUNT;
           ACT/1,UNFRM(1,3),.75,LOAD;      75% SUCCESS ON FIRST SHOT
           ACT/2,UNFRM(1,3),.25,MISS;      25% CHANCE OF MISSING
MISS  GOON,1;
           ACT/3,UNFRM(1,3),.75,LOAD;      FIRE AGAIN IF MISSED BIRD
           ACT/4,UNFRM(1,3),.25,RLOD;      25% CHANCE OF MISSING
RLOD  GOON,1;
           ACT/5,UNFRM(2,4);               RELOAD GUN, MISSED BIRD
      FREE,HUNT;
      TERM;
LOAD  GOON,1;
           ACT/6,UNFRM(2,4);               RELOAD GUN, SHOT BIRD
      FREE,HUNT;
      TERM,1000;                           SIMULATE FOR 1000 HITS
      ENDNETWORK;
FIN;
```

S L A M S U M M A R Y R E P O R T

SIMULATION PROJECT HUNTING BIRDS #13 BY BRADLEY

DATE 5/30/1985 RUN NUMBER 1 OF 1

CURRENT TIME 0.1073E+05
STATISTICAL ARRAYS CLEARED AT TIME 0.0000E+00

FILE STATISTICS

FILE NUMBER	ASSOCIATED NODE TYPE	AVERAGE LENGTH	STANDARD DEVIATION	MAXIMUM LENGTH	CURRENT LENGTH	AVERAGE WAITING TIME
1	AWAIT	0.0000	0.0000	1	0	0.0000
2	QUEUE	0.0000	0.0000	0	0	0.0000
3	CALENDAR	1.5414	0.4984	2	1	2.4954

REGULAR ACTIVITY STATISTICS

ACTIVITY INDEX	AVERAGE UTILIZATION	STANDARD DEVIATION	MAXIMUM UTILIZATION	CURRENT UTILIZATION	ENTITY COUNT
1	0.1479	0.3550	1	0	796
2	0.0482	0.2141	1	0	263
3	0.0381	0.1916	1	0	204
4	0.0104	0.1012	1	0	59
5	0.0163	0.1265	1	0	59
6	0.2807	0.4493	1	0	1000

RESOURCE STATISTICS

RESOURCE NUMBER	RESOURCE LABEL	CURRENT CAPACITY	AVERAGE UTILIZATION	STANDARD DEVIATION	MAXIMUM UTILIZATION	CURRENT UTILIZATION
1	HUNT	1	0.5415	0.4983	1	0

RESOURCE NUMBER	RESOURCE LABEL	CURRENT AVAILABLE	AVERAGE AVAILABLE	MINIMUM AVAILABLE	MAXIMUM AVAILABLE
1	HUNT	1	0.4585	0	1

P C S L A M S U M M A R Y R E P O R T

HUNTING BIRDS #13

CPU TIME: 10 MIN 45 SEC
TOTAL TIME TO RUN MODEL: 17 MIN 05 SEC

SIMULATION PROJECT HUNTING BIRDS #13 BY BRADLEY

DATE 6/27/1985 RUN NUMBER 1 OF 1

CURRENT TIME .1071E+05
STATISTICAL ARRAYS CLEARED AT TIME .0000E+00

FILE STATISTICS

FILE NUMBER	ASSOCIATED NODE TYPE	AVERAGE LENGTH	STANDARD DEVIATION	MAXIMUM LENGTH	CURRENT LENGTH	AVERAGE WAIT TIME
1	AWAIT	.000	.000	1	0	.000
2	QUEUE	.000	.000	0	0	.000
3	CALENDAR	1.548	.498	2	1	2.477

REGULAR ACTIVITY STATISTICS

ACTIVITY INDEX	AVERAGE UTILIZATION	STANDARD DEVIATION	MAXIMUM UTILIZATION	CURRENT UTILIZATION	ENTITY COUNT
1	.1467	.3538	1	0	793
2	.0517	.2214	1	0	275
3	.0372	.1893	1	0	207
4	.0124	.1106	1	0	68
5	.0198	.1392	1	0	68
6	.2800	.4490	1	0	1000

RESOURCE STATISTICS

RESOURCE NUMBER	RESOURCE LABEL	CURRENT CAPACITY	AVERAGE UTIL	STANDARD DEVIATION	MAXIMUM UTIL	CURRENT UTIL
1	HUNT	1	.55	.498	1	0

RESOURCE NUMBER	RESOURCE LABEL	CURRENT AVAILABLE	AVERAGE AVAILABLE	MINIMUM AVAILABLE	MAXIMUM AVAILABLE
1	HUNT	1	.4522	0	1

```
BLOCK
NUMBER   *LOC    OPERATION  A,B,C,D,E,F,G,H,I          COMMENTS
         * HUNTING BIRDS #13
                  SIMULATE
1                 GENERATE   10,2                BIRDS PASS EVERY 10 SECS +OR- 2
2                 TRANSFER   BOTH,HUNT,BUSY      SEE IF THE HUNTER IS FREE
3         HUNT    SEIZE      HUNTR               BEGIN SHOOTING
4                 ADVANCE    2,1                 2 SECS +OR- 1 TO FIRE FIRST SHOT
5                 TRANSFER   .25,LOAD,WRONG      75% SUCCESS ON THE FIRST SHOT
6         WRONG   ADVANCE    2,1                 2 SECS +OR- 1 TO FIRE SECOND SHOT
7                 TRANSFER   .25,LOAD,RLOAD      75% SUCCESS ON THE SECOND SHOT
          *                                       RELOAD AFTER TWO SHOTS
8         LOAD    ADVANCE    3,1                 RELOADING TAKES 3 SECS +OR- 1
9                 RELEASE    HUNTR               THE HUNTER IS FREE AGAIN
10                TERMINATE  1                   COUNT THE NUMBER OF BIRDS KILLED
11        RLOAD   ADVANCE    3,1                 RELOADING TAKES 3 SECS +OR- 1
12                RELEASE    HUNTR               THE HUNTER IS FREE AGAIN
13        BUSY    TERMINATE
                  START      1000                SIMULATE UNTIL 1,000 BIRDS ARE KILLED
                  END
```

```
PROCESSOR TIME ---------0.00023 CPU HOURS @ $1,135.00 --------0.26
PROCESSOR STORAGE ------0.02773 K-BYTE HOURS @  $0.25 --------0.01
GPSS                              TOTAL PROCESSOR COST -------$0.27
DISK EXCPS -----------------121 @  $0.36 PER 1000 ------------0.04
                I/O COST (EXCLUDING PRINTER/READER/PUNCH) -------$0.04

TOTAL COST ----------------------------------------------------$0.31
```

RELATIVE CLOCK 10988 ABSOLUTE CLOCK 10988

BLOCK COUNTS

BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL
1	0	1102	11	0	70									
2	0	1102	12	0	70									
3	0	1070	13	0	102									
4	0	1070												
5	0	1070												
6	0	270												
7	0	270												
8	0	1000												
9	0	1000												
10	0	1000												

FACILITIES

FACILITY	NUMBER ENTRIES	AVERAGE TIME/TRAN	-AVERAGE UTILIZATION DURING- TOTAL TIME	AVAIL. TIME	UNAVAIL. TIME	CURRENT STATUS	PERCENT AVAILABILITY	TRANSACTION NUMBER SEIZING	PREEMPTING
HUNTR	1070	5.491	.534				100.0		

END

***** TOTAL RUN TIME (INCLUDING ASSEMBLY) = .00 MINUTES *****

SUPERHIGHWAY #14

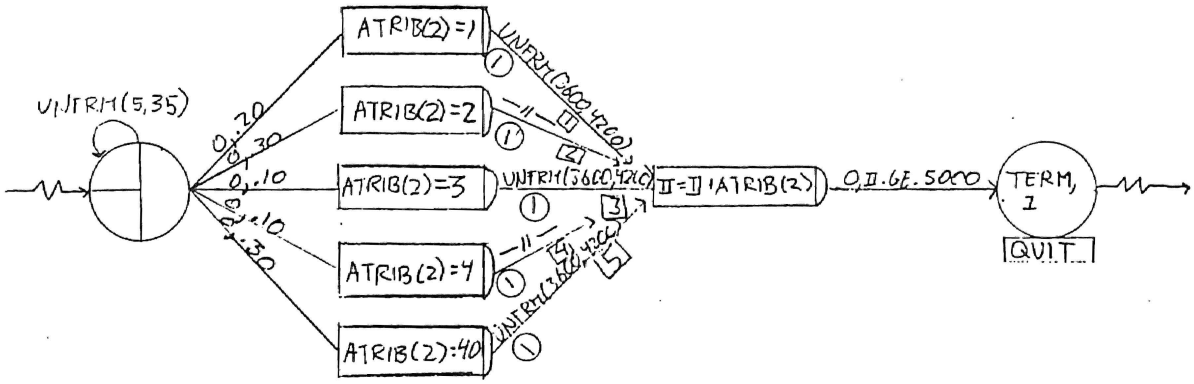
A superhighway connects one large metropolitan area to another. A vehicle leaves the first city every 20 + or - 15 seconds. Twenty percent of the vehicles have 1 passenger, 30% of the vehicles have 2 passengers, 10% have 3 passengers, and 10% have 4 passengers. The remaining 30% of the vehicles are buses which carry 40 people. It takes 60 + or - 10 minutes for a vehicle to travel between the two metropolitan areas. How long does it take for 5000 people to arrive in the second city?

ANAYSIS OF SLAM, PC SLAM, AND GPSS RUNS

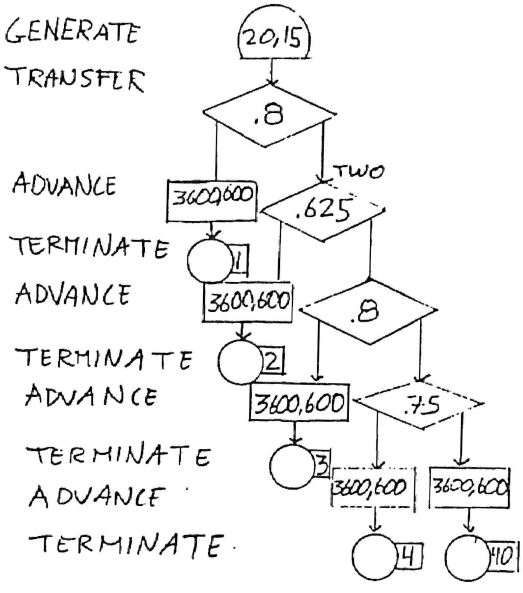
With GPSS, there were:	With SLAM, there were:	PC SLAM:
1 Pass. Cars: 61	1 Pass. Cars: 76	67
2 Pass. Cars: 97	2 Pass. Cars: 70	71
3 Pass. Cars: 37	3 Pass. Cars: 34	27
4 Pass. Cars: 40	4 Pass. Cars: 69	81
40 Pass. Bus: 112	40 Pass. Bus: 111	110
Total Time : 175.7 Hours	Total Time : 176.6 Hours	176.6 Hours

The results compare reasonably, especially in regards to the total time it takes for 5000 passengers to reach the second city. The most notable thing about this model is the different structures of the SLAM and GPSS solutions. It is necessary to use minutes as the basic unit of time in SLAM, as opposed to seconds for GPSS. Using seconds in SLAM results in an error message and the system crashing.

SLAM NETWORK DIAGRAM SUPERHIGHWAY #14



GPSS NETWORK DIAGRAM



```
  1  GEN,BRADLEY,SUPERHIGHWAY #14,5/29/85;
  2  LIMITS,0,2,500;
  3  NETWORK;
  4        CREATE,UNFRM(.08,.58);
  5            ACT/6,,.2,CAR1;
  6            ACT/7,,.2,CAR2;
  7            ACT/8,,.1,CAR3;
  8            ACT/9,,.2,CAR4;
  9            ACT/10,,.3,BUS;
 10  CAR1  ASSIGN,ATRIB(2)=1;
 11            ACT/1,UNFRM(50,70),,ADD;      ONE PASSENGER
 12  CAR2  ASSIGN,ATRIB(2)=2;
 13            ACT/2,UNFRM(50,70),,ADD;      TWO PASSENGERS
 14  CAR3  ASSIGN,ATRIB(2)=3;
 15            ACT/3,UNFRM(50,70),,ADD;      THREE PASSENGERS
 16  CAR4  ASSIGN,ATRIB(2)=4;
 17            ACT/4,UNFRM(50,70),,ADD;      FOUR PASSENGERS
 18  BUS   ASSIGN,ATRIB(2)=40;
 19            ACT/5,UNFRM(50,70),,ADD;      FOURTY PASSENGERS
 20  ADD   ASSIGN,II=II+ATRIB(2);
 21            ACT,0,II.GE.5000,QUIT;           SIMULATE FOR 5,000 PASSENGERS
 22  QUIT  TERM,1;
 23        ENDNETWORK;
 24  FIN;
```

```
                                                    CPU     0MIN 01.17SEC
------------------------------------------------------------------------------
PROCESSOR TIME ---------0.00042 CPU HOURS @ $1,135.00 --------0.48
PROCESSOR STORAGE ------0.22880 K-BYTE HOURS @  $0.25 --------0.06
SLAM                             TOTAL PROCESSOR COST -------$0.54

DISK EXCPS -------------------49 @  $0.36 PER 1000 -----------0.01
                I/O COST (EXCLUDING PRINTER/READER/PUNCH) -------$0.01

TOTAL COST (AFTER       $0.33   3RD SHIFT DISCOUNT) ---------$0.22
```

S L A M S U M M A R Y R E P O R T

SIMULATION PROJECT SUPERHIGHWAY #14 BY BRADLEY

DATE 5/29/1985 RUN NUMBER 1 OF 1

CURRENT TIME 0.1766E+03
STATISTICAL ARRAYS CLEARED AT TIME 0.0000E+00

REGULAR ACTIVITY STATISTICS

ACTIVITY INDEX	AVERAGE UTILIZATION	STANDARD DEVIATION	MAXIMUM UTILIZATION	CURRENT UTILIZATION	ENTITY COUNT
1	30.3682	9.6381	43	28	76
2	29.4888	12.3230	42	37	70
3	13.5697	6.4928	22	18	34
4	32.1355	13.4699	47	47	69
5	46.2331	13.4333	59	54	111
6	0.0000	0.0000	1	0	104
7	0.0000	0.0000	1	0	107
8	0.0000	0.0000	1	0	52
9	0.0000	0.0000	1	0	116
10	0.0000	0.0000	1	0	165

P C S L A M S U M M A R Y R E P O R T

SUPERHIGHWAY #14

CPU TIME: 4 MIN 49 SEC
TOTAL TIME TO RUN MODEL: 11 MIN 10 SEC

SIMULATION PROJECT SUPERHIGHWAY #14 BY BRADLEY

DATE 6/27/1985 RUN NUMBER 1 OF 1

CURRENT TIME .1766E+03
STATISTICAL ARRAYS CLEARED AT TIME .0000E+00

REGULAR ACTIVITY STATISTICS

ACTIVITY INDEX	AVERAGE UTILIZATION	STANDARD DEVIATION	MAXIMUM UTILIZATION	CURRENT UTILIZATION	ENTITY COUNT
1	26.9692	9.6644	37	30	67
2	30.0184	11.4440	42	38	71
3	13.0519	5.5380	21	20	27
4	33.2190	10.4799	48	36	81
5	46.2833	16.9591	66	53	110
6	.0000	.0000	1	0	97
7	.0000	.0000	1	0	109
8	.0000	.0000	1	0	47
9	.0000	.0000	1	0	117
10	.0000	.0000	1	0	163

```
BLOCK                                                                    CPU     0MIN 00.38SEC
NUMBER   *LOC   OPERATION  A,B,C,D,E,F,G,H,I          COMMENTS
         *234567*9012345678*01234567890*
         * SUPERHIGHWAY #14
               SIMULATE
1              GENERATE    20,15         ONE VEHICLE EVERY 20 SEC +OR- 15
2              TRANSFER    .8,,TWO
3              ADVANCE     3600,600
4              TERMINATE   1             ONE PASSENGER
5         TWO  TRANSFER    .625,,THREE
6              ADVANCE     3600,600        *
7              TERMINATE   2             TWO PASSENGERS
8         THREE TRANSFER   .8,,FOUR
9              ADVANCE     3600,600
10             TERMINATE   3             THREE PASSENGERS
11        FOUR TRANSFER    .75,,BUS
12             ADVANCE     3600,600
13             TERMINATE   4             FOUR PASSENGERS
14        BUS  ADVANCE     3600,600
15             TERMINATE   40            FOURTY PASSENGERS
               START       5000
               END
```

```
PROCESSOR TIME ---------0.00020 CPU HOURS @ $1,135.00 --------0.23
PROCESSOR STORAGE ------0.02196 K-BYTE HOURS @  $0.25 --------0.01
GPSS                                TOTAL PROCESSOR COST -------$0.24

DISK EXCPS ------------------129 @  $0.36 PER 1000 ------------0.04
                I/O COST (EXCLUDING PRINTER/READER/PUNCH) -------$0.04

TOTAL COST ---------------------------------------------------$0.28
```

```
RELATIVE CLOCK          10543  ABSOLUTE CLOCK          10543
BLOCK COUNTS
BLOCK CURRENT     TOTAL     BLOCK CURRENT     TOTAL     BLOCK CURRENT     TOTAL     BLOCK CURRENT     TOTAL     BLOCK CURRENT     TOTAL
    1       0       531        11       0       227
    2       0       531        12      14        54
    3      35        96        13       0        40
    4       0        61        14      61       173
    5       0       435        15       0       112
    6      52       149
    7       0        97
    8       0       286
    9      22        59
   10       0        37
      END

                        ***** TOTAL RUN TIME (INCLUDING ASSEMBLY) =  .00 MINUTES *****
```

MEAT COUNTER #15

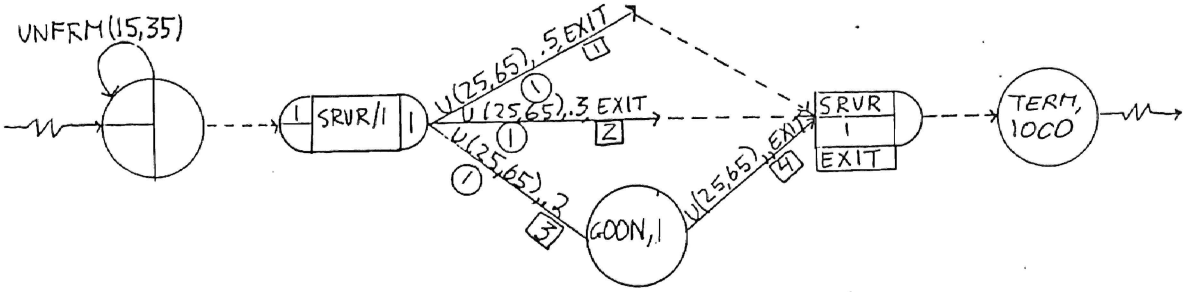
People arrive at a meat counter at a rate of one every 25 + or - 10 seconds. There are two sections: one for beef and one for pork. People want goods from them in the following proportion: beef only, 50%; pork only, 30%; beef and pork, 20%. It takes 45 + or - seconds for a butcher to serve one customer for one order. All customers place one order, except "beef and pork" customers place two orders. Assume that there are three butchers available at all times to handle customers. Simulate until 1000 customers are served.

ANALYSIS OF SLAM, PC SLAM, AND GPSS RUNS

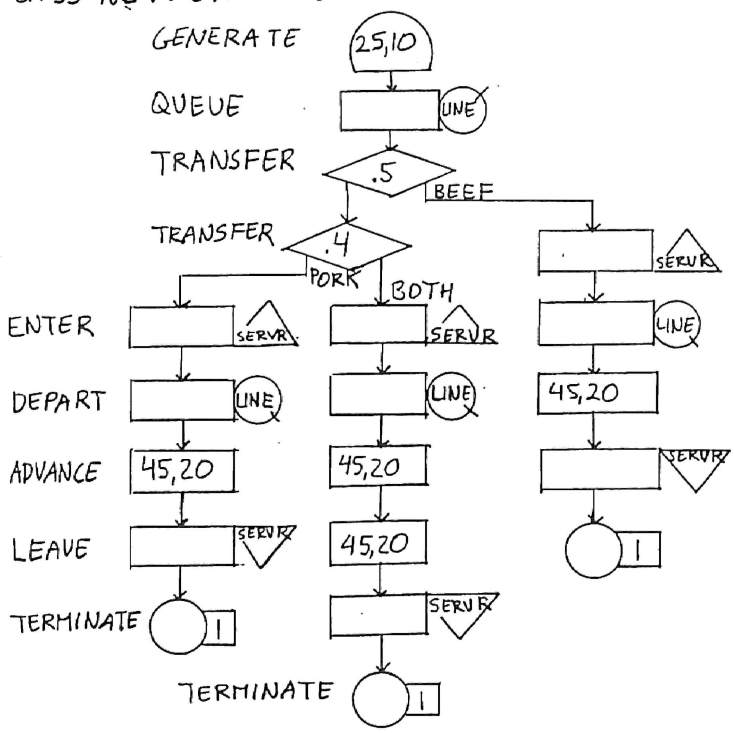
The total time required for the simulation is 25350 seconds in SLAM, 12390 (24780 doubled) seconds in PC SLAM (The PC simulation was for 500 customers, but if the results are doubled they will be comparable to a PC run of 1000 customers. The standard deviation would be lower if 1000 customers were simulated.), and 24952 seconds in GPSS. On the average, there were 2.109 servers busy all the time in SLAM, 2.18 servers busy in PC SLAM, and 2.159 in GPSS. In SLAM, 509 people bought beef, 306 bought pork, and 186 bought both. In PC SLAM, 235 (470 doubled) people bought beef, 162 (324 doubled) bought pork, and 103 (206 doubled) bought both. In GPSS, 511 people bought beef, 294 bought pork, and 196 bought both. The two sets of data compare extremely well for this model.

SLAM NETWORK DIAGRAM

MEAT COUNTER #15



GPSS NETWORK DIAGRAM



```
  1  GEN,BRADLEY,MEAT COUNTER #15,5/29/85,1;
  2  LIMITS,1,0,500;
  3  NETWORK;
  4        RESOURCE/SRVR(3),1;                THREE SERVERS
  5        CREATE,UNFRM(15,35);
  6        AWAIT(1),SRVR/1;                   AWAIT A FREE SERVER
  7             ACT/1,UNFRM(25,65),.5,EXIT;   BUY BEEF
  8             ACT/2,UNFRM(25,65),.3,EXIT;   BUY PORK
  9             ACT/3,UNFRM(25,65),.2;        BUY BOTH, GET FIRST MEAT
 10        GOON,1;
 11             ACT/4,UNFRM(25,65),,EXIT;     GET SECOND TYPE OF MEAT
 12  EXIT  FREE,SRVR/1;                       SERVER IS NOW FREE
 13        TERM,1000;                         SIMULATE FOR 1000 CUSTOMERS
 14        ENDNETWORK;
 15  FIN;
```

```
                                                    CPU     0MIN 01.46SEC
-------------------------------------------------------------------------
PROCESSOR TIME ---------0.00050 CPU HOURS @ $1,135.00 --------0.57
PROCESSOR STORAGE ------0.28551 K-BYTE HOURS @  $0.25 --------0.07
SLAM                                    TOTAL PROCESSOR COST -------$0.64
DISK EXCPS -----------------50 @  $0.36 PER 1000 ------------0.02
                        I/O COST (EXCLUDING PRINTER/READER/PUNCH) -------$0.02
TOTAL COST ------------------------------------------------------------$0.66
```

S L A M S U M M A R Y R E P O R T

SIMULATION PROJECT MEAT COUNTER #15 BY BRADLEY

DATE 5/29/1985 RUN NUMBER 1 OF 1

CURRENT TIME 0.2535E+05
STATISTICAL ARRAYS CLEARED AT TIME 0.0000E+00

FILE STATISTICS

FILE NUMBER	ASSOCIATED NODE TYPE	AVERAGE LENGTH	STANDARD DEVIATION	MAXIMUM LENGTH	CURRENT LENGTH	AVERAGE WAITING TIME
1	AWAIT	0.0467	0.2188	2	0	1.1800
2	CALENDAR	3.1082	0.7124	5	4	18.7752

REGULAR ACTIVITY STATISTICS

ACTIVITY INDEX	AVERAGE UTILIZATION	STANDARD DEVIATION	MAXIMUM UTILIZATION	CURRENT UTILIZATION	ENTITY COUNT
1	0.9127	0.7373	3	2	509
2	0.5342	0.6306	3	0	306
3	0.3264	0.5303	3	0	186
4	0.3352	0.5510	3	1	185

RESOURCE STATISTICS

RESOURCE NUMBER	RESOURCE LABEL	CURRENT CAPACITY	AVERAGE UTILIZATION	STANDARD DEVIATION	MAXIMUM UTILIZATION	CURRENT UTILIZATION
1	SRVR	3	2.1085	0.7108	3	3

RESOURCE NUMBER	RESOURCE LABEL	CURRENT AVAILABLE	AVERAGE AVAILABLE	MINIMUM AVAILABLE	MAXIMUM AVAILABLE
1	SRVR	0	0.8914	0	3

```
GEN,BRADLEY,MEAT COUNTER #15,6/27/85,1;
LIMITS,1,0,500;
NETWORK;
      RESOURCE/SRVR(3),1;                  THREE SERVERS
      CREATE,UNFRM(15,35);
      AWAIT(1),SRVR/1;                     AWAIT A FREE SERVER
          ACT/1,UNFRM(25,65),.5,EXIT;      BUY BEEF
          ACT/2,UNFRM(25,65),.3,EXIT;      BUY PORK
          ACT/3,UNFRM(25,65),.2;           BUY BOTH, GET FIRST MEAT
      GOON,1;
          ACT/4,UNFRM(25,65),,EXIT;        GET SECOND TYPE OF MEAT
EXIT  FREE,SRVR/1;                         SERVER IS NOW FREE
      TERM,500;                            SIMULATE FOR 500 CUSTOMERS
      ENDNETWORK;
FIN;
```

P C S L A M S U M M A R Y R E P O R T

MEAT COUNTER #15

CPU TIME: 12 MIN 06 SEC
TOTAL TIME TO RUN MODEL: 18 MIN 00 SEC

SIMULATION PROJECT MEAT COUNTER #15 BY BRADLEY

DATE 6/27/1985 RUN NUMBER 1 OF 1

CURRENT TIME .1239E+05
STATISTICAL ARRAYS CLEARED AT TIME .0000E+00

FILE STATISTICS

FILE NUMBER	ASSOCIATED NODE TYPE	AVERAGE LENGTH	STANDARD DEVIATION	MAXIMUM LENGTH	CURRENT LENGTH	AVERAGE WAIT TIME
1	AWAIT	.061	.246	2	0	1.508
2	CALENDAR	3.178	.721	5	2	18.689

REGULAR ACTIVITY STATISTICS

ACTIVITY INDEX	AVERAGE UTILIZATION	STANDARD DEVIATION	MAXIMUM UTILIZATION	CURRENT UTILIZATION	ENTITY COUNT
1	.8391	.7511	3	1	235
2	.5781	.6543	3	0	162
3	.3962	.5505	2	0	103
4	.3650	.5335	2	0	103

RESOURCE STATISTICS

RESOURCE NUMBER	RESOURCE LABEL	CURRENT CAPACITY	AVERAGE UTIL	STANDARD DEVIATION	MAXIMUM UTIL	CURRENT UTIL
1	SRVR	3	2.18	.721	3	1

RESOURCE NUMBER	RESOURCE LABEL	CURRENT AVAILABLE	AVERAGE AVAILABLE	MINIMUM AVAILABLE	MAXIMUM AVAILABLE
1	SRVR	2	.8215	0	3

```
BLOCK                                                                                                    CPU     0MIN 00.46SEC
NUMBER   *LOC    OPERATION  A,B,C,D,E,F,G,H,I          COMMENTS          ------------------------------------------------------------------
         *234567*9012345678*01234567890*                                 PROCESSOR TIME ---------0.00022 CPU HOURS @ $1,135.00 --------0.25
         * MEAT  COUNTER #15                                             PROCESSOR STORAGE ------0.02658 K-BYTE HOURS @  $0.25 --------0.01
                SIMULATE                                                                                  TOTAL PROCESSOR COST -------$0.26
                SERVR STORAGE    3                                      GPSS
1               GENERATE   25,10       ONE CUSTOMER EVERY 25 SECS +OR- 10 DISK EXCPS ------------------158 @  $0.36 PER 1000 -----------0.05
2               QUEUE      LINE                                                    I/O COST (EXCLUDING PRINTER/READER/PUNCH) -------$0.05
3               TRANSFER   .5,,BEEF         50% WANT BEEF ONLY
4               TRANSFER   .4,PORK,BOTH     40% WANT BEEF, 20% WANT BOTH    TOTAL COST (AFTER       $0.19   3RD SHIFT DISCOUNT) ---------$0.12
5               PORK   ENTER       SERVR
6               DEPART     LINE
7               ADVANCE    45,20       BUY PORK
8               LEAVE      SERVR
9               TERMINATE  1
10              BEEF   ENTER       SERVR
11              DEPART     LINE
12              ADVANCE    45,20       BUY BEEF
13              LEAVE      SERVR
14              TERMINATE  1
15              BOTH   ENTER       SERVR
16              DEPART     LINE
17              ADVANCE    45,20       BUY BEEF
18              ADVANCE    45,20       BUY PORK
19              LEAVE      SERVR
20              TERMINATE  1
                START      1000
                END
```

RELATIVE CLOCK 24952 ABSOLUTE CLOCK 24952

BLOCK COUNTS

BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL
1	0	1001	11	0	511									
2	0	1001	12	0	511									
3	0	1001	13	0	511									
4	0	490	14	0	511									
5	0	294	15	0	196									
6	0	294	16	0	196									
7	0	294	17	1	196									
8	0	294	18	0	195									
9	0	294	19	0	195									
10	0	511	20	0	195									

```
*****************************************
*                                       *
*              STORAGES                 *
*                                       *
*****************************************
```

STORAGE	CAPACITY	AVERAGE CONTENTS	ENTRIES	AVERAGE TIME/UNIT	-AVERAGE TOTAL TIME	UTILIZATION DURING- AVAIL. TIME	UNAVAIL. TIME	CURRENT STATUS	PERCENT AVAILABILITY	CURRENT CONTENTS	MAXIMUM CONTENTS
SERVR	3	2.159	1001	53.823	.719				100.0	1	3

```
*****************************************
*                                       *
*               QUEUES                  *
*                                       *
*****************************************
```

QUEUE	MAXIMUM CONTENTS	AVERAGE CONTENTS	TOTAL ENTRIES	ZERO ENTRIES	PERCENT ZEROS	AVERAGE TIME/TRANS	$AVERAGE TIME/TRANS	TABLE NUMBER	CURRENT CONTENTS
LINE	2	.070	1001	842	84.1	1.747	11.000		

$AVERAGE TIME/TRANS = AVERAGE TIME/TRANS EXCLUDING ZERO ENTRIES

END

***** TOTAL RUN TIME (INCLUDING ASSEMBLY) = .00 MINUTES *****

CLINIC #20

In a 24 hour multiphasic screening clinic, patients arrive at a rate of one every 5 + or - 2 minutes to enter the audiology section. Examination takes 3 + or - 1 minutes. Eighty percent of the patients are passed on to the next test with no problems. Of the remaining 20%, one-half require simple procedures which take 2 + or - 1 minutes and are then sent for reexamination with the same probability of failure. The other half are sent home with medication. Simulate the system to determine how long it takes to screen and pass 1500 patients.

ANAYLSIS OF GPSS AND SLAM RUNS

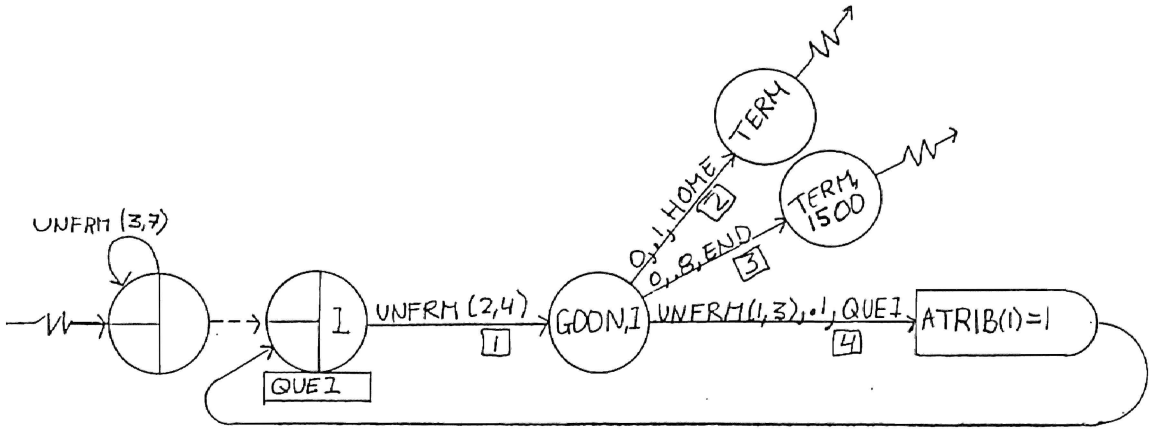
The SLAM results are:		The GPSS results are:	
System Time	8621 min.	System Time	8465 min.
Waiting	.371 min.	Avg. Wait for Exam	.462
Avg. Util. Examiner	.660	Avg. Util. Examiner	.663
Patients Sent Home	218	Patients Sent Home	180
# Needing Procedure	178	# Needing Procedure	188
Total Examined	1500	Total Examined	1500

All results are in the same ballpark. There is some variation in output due to the inherent variability caused by the different random number streams.

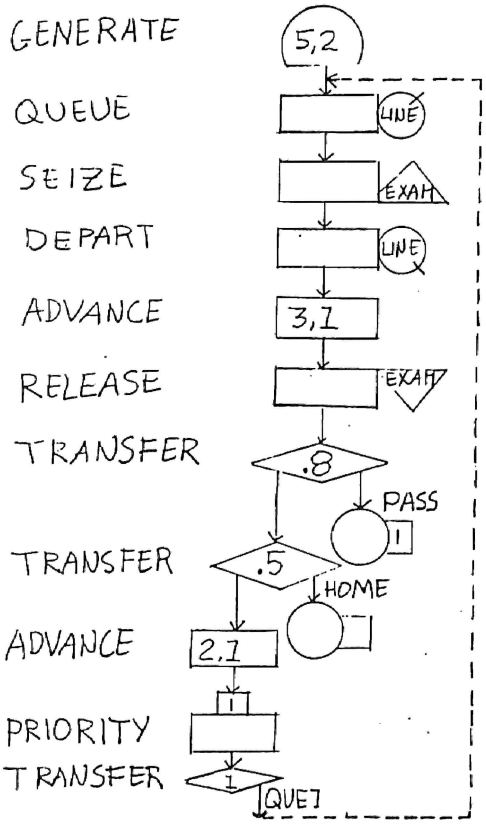
Also attached to this model are the programs and results for four simulations, each in modelled in both SLAM and GPSS, using different random number streams. The data sets containing the programs are included. These data sets include the JCL necessary to run SLAM and GPSS on the IBM 3081 D.

A listing of the SLAM PC program is attached too. The important thing to note is the discrepancy between the SEEDS values set in the program, and the SEEDS values listed under the SEED VALUE section of the Echo Report. These differences are explained in the section of this report dealing with pseudorandom number generation. The CPU time for running the SLAM PC program was 9 minutes and 49 seconds, as compared to 1.94 seconds to run the same program on the IBM 3081 D. Two SLAM SUMMARY REPORTs for different random number seed values are also listed.

SLAM NETWORK DIAGRAM CLINIC #20



GPSS NETWORK DIAGRAM



```
  1  GEN,BRADLEY,CLINIC #20,6/2/85,1;
  2  LIMITS,1,1,500;
  3  PRIORITY/1,HVF(1);                SET PRIORITY FOR FILE 1
  4  NETWORK;
  5        CREATE,UNFRM(3,7);          UNIFORM DISTRIBUTION OF PATIENTS
  6  QUE1  QUEUE(1);
  7           ACT/1,UNFRM(2,4);        EXAMINATION
  8        GOON,1;
  9           ACT/2,,,1,HOME;          10% GO HOME WITH MEDICATION
 10           ACT/3,,,8,END;           80% GO TO NEXT TEST
 11           ACT/4,UNFRM(1,3),,1;     10% NEED A SIMPLE PROCEEDURE
 12        ASSIGN,ATRIB(1)=1,1;        ASSIGN PRIORITY
 13        GOON,1;                     NEED A NODE BETWEEN ACTIVITIES
 14           ACT/5,,,QUE1;            RETURN FOR REEXAMINATION
 15  HOME  TERMINATE;                  IF SENT HOME NOT CONSIDERED PASSED
 16  END   TERMINATE,1500;             SIMULATE FOR 1500 PATIENTS
 17        ENDNETWORK;
```

```
                                                        CPU     0MIN 01.94SEC
-------------------------------------------------------------------------------
PROCESSOR TIME ---------0.00063 CPU HOURS @ $1,135.00 --------0.72
PROCESSOR STORAGE ------0.37938 K-BYTE HOURS @  $0.25 --------0.09
SLAM                                TOTAL PROCESSOR COST -------$0.81
DISK EXCPS -------------------38 @  $0.36 PER 1000 -----------0.01
                  I/O COST (EXCLUDING PRINTER/READER/PUNCH) -------$0.01

TOTAL COST (AFTER       $0.49   3RD SHIFT DISCOUNT) ---------$0.33
```

S L A M S U M M A R Y R E P O R T

SIMULATION PROJECT CLINIC #20 BY BRADLEY

DATE 6/ 2/1985 RUN NUMBER 1 OF 1

CURRENT TIME 0.8621E+04
STATISTICAL ARRAYS CLEARED AT TIME 0.0000E+00

FILE STATISTICS

FILE NUMBER	ASSOCIATED NODE TYPE	AVERAGE LENGTH	STANDARD DEVIATION	MAXIMUM LENGTH	CURRENT LENGTH	AVERAGE WAITING TIME
1	QUEUE	0.0815	0.2936	3	0	0.3705
2	CALENDAR	1.7009	0.4915	4	1	2.3927

REGULAR ACTIVITY STATISTICS

ACTIVITY INDEX	AVERAGE UTILIZATION	STANDARD DEVIATION	MAXIMUM UTILIZATION	CURRENT UTILIZATION	ENTITY COUNT
2	0.0000	0.0000	1	0	218
3	0.0000	0.0000	1	0	1500
4	0.0413	0.1991	2	0	178
5	0.0000	0.0000	1	0	178

SERVICE ACTIVITY STATISTICS

ACTIVITY INDEX	START NODE LABEL/TYPE	SERVER CAPACITY	AVERAGE UTILIZATION	STANDARD DEVIATION	CURRENT UTILIZATION	AVERAGE BLOCKAGE	MAXIMUM IDLE TIME/SERVERS	MAXIMUM BUSY TIME/SERVERS	ENTITY COUNT
1	QUE1 QUEUE	1	0.6597	0.4738	0	0.0000	4.8799	45.5430	1896

```
BLOCK                                                                                                    CPU     0MIN 00.62SEC
NUMBER   *LOC    OPERATION  A,B,C,D,E,F,G,H,I          COMMENTS
         *234567*9012345678*01234567890*
         * CLINIC #20
                  SIMULATE
1                 GENERATE   5,2
2          QUE    QUEUE      LINE          WAIT FOR EXAMINATION
3                 SEIZE      EXAM
4                 DEPART     LINE
5                 ADVANCE    3,1           RECEIVE EXAM
6                 RELEASE    EXAM
7                 TRANSFER   .8,,PASS      80% PASS EXAM
8                 TRANSFER   .5,,HOME      50% OF THE REST GO HOME
9          SPR    ADVANCE    2,1           OTHERS NEED A SIMPLE PROCEEDURE
10                PRIORITY   1             GO TO HEAD OF LINE
11                TRANSFER   .QUE          RETURN FOR REEXAMINATION
12         HOME   TERMINATE                 NOT CONSIDERED PASSED IF SENT HOME
13         PASS   TERMINATE  1
                  START      1500          SIMULATE FOR 1500 PATIENTS
                  END
```

GPSS

```
PROCESSOR TIME ---------0.00026 CPU HOURS @ $1,135.00 --------0.30
PROCESSOR STORAGE ------0.03582 K-BYTE HOURS @  $0.25 --------0.01
                                 TOTAL PROCESSOR COST -------$0.31
DISK EXCPS -----------------126 @  $0.36 PER 1000 ------------0.04
                   I/O COST (EXCLUDING PRINTER/READER/PUNCH) -------$0.04

TOTAL COST (AFTER       $0.21   3RD SHIFT DISCOUNT) ---------$0.14
```

RELATIVE CLOCK 8465 ABSOLUTE CLOCK 8465

BLOCK COUNTS

BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL
1	0	1681	11	0	188									
2	1	1869	12	0	180									
3	0	1868	13	0	1500									
4	0	1868												
5	0	1868												
6	0	1868												
7	0	1868												
8	0	368												
9	0	188												
10	0	188												

FACILITIES

FACILITY	NUMBER ENTRIES	AVERAGE TIME/TRAN	-AVERAGE TOTAL TIME	UTILIZATION DURING- AVAIL. TIME	UNAVAIL. TIME	CURRENT STATUS	PERCENT AVAILABILITY	TRANSACTION NUMBER SEIZING	PREEMPTING
EXAM	1868	3.007	.663				100.0		

QUEUES

QUEUE	MAXIMUM CONTENTS	AVERAGE CONTENTS	TOTAL ENTRIES	ZERO ENTRIES	PERCENT ZEROS	AVERAGE TIME/TRANS	$AVERAGE TIME/TRANS	TABLE NUMBER	CURRENT CONTENTS
LINE	3	.102	1869	1457	77.9	.462	2.097		1

$AVERAGE TIME/TRANS = AVERAGE TIME/TRANS EXCLUDING ZERO ENTRIES

END

***** TOTAL RUN TIME (INCLUDING ASSEMBLY) = .00 MINUTES *****

```
**** TSO FOREGROUND HARDCOPY ****
DSNAME=U15799A.PROB20.SLAM.DATA

//U15799AC  JOB (15799,SSS-SS-SSSS),'BRADLEY',CLASS=A,                  00000010
//  TIME=(0,10),MSGCLASS=X,NOTIFY=U15799A                               00000020
/*PASSWORD ?                                                           00000030
/*JOBPARM FORMS=9001,ROOM=R,COPIES=1                                   00000040
//  EXEC SLAM                                                          00000050
//SLAM.SYSIN DD *                                                      00000060
GEN,BRADLEY,CLINIC #20,6/13/85,4;                                      00000070
LIMITS,1,3,500;                                                        00000080
PRIORITY/1,HVF(1);              SET PRIORITY FOR FILE 1                00000090
SEEDS,42895(1)/NO;                                                     00000100
NETWORK;                                                               00000110
      CREATE,UNFRM(3,7);        UNIFORM DISTRIBUTION OF PATIENTS       00000120
QUE1  QUEUE(1);                                                        00000130
          ACT/1,UNFRM(2,4);     EXAMINATION                            00000140
      GOON,1;                                                          00000150
          ACT/2,,.1,HOME;       10% GO HOME WITH MEDICATION            00000160
          ACT/3,,.8,END;        80% GO TO NEXT TEST                    00000170
          ACT/4,UNFRM(1,3),.1;  10% NEED A SIMPLE PROCEEDURE           00000180
      ASSIGN,ATRIB(1)=1,1;      ASSIGN PRIORITY                        00000190
      GOON,1;                   NEED A NODE BETWEEN ACTIVITIES         00000200
          ACT/5,,,QUE1;         RETURN FOR REEXAMINATION               00000210
HOME  TERMINATE;                IF SENT HOME NOT CONSIDERED PASSED     00000220
END   TERMINATE,1500;           SIMULATE FOR 1500 PATIENTS             00000230
      ENDNETWORK;                                                      00000240
SIMULATE;                                                              00000250
SEEDS,79416(1)/NO;                                                     00000260
MONTR,SUMRY,.1000E+21,,;                                               00000270
SIMULATE;                                                              00000280
SEEDS,20049(1)/NO;                                                     00000290
MONTR,SUMRY,.1000E+21,,;                                               00000300
SIMULATE;                                                              00000310
SEEDS,63381(1)/NO;                                                     00000320
MONTR,SUMRY,.1000E+21,;                                                00000330
FIN;                                                                   00000340
//                                                                     00000350
```

```
                                                    CPU     0MIN 06.79SEC
-------------------------------------------------------------------------
PROCESSOR TIME ---------0.00198 CPU HOURS @ $1,135.00 --------2.25
PROCESSOR STORAGE ------1.32782 K-BYTE HOURS @  $0.25 --------0.33
SLAM                                 TOTAL PROCESSOR COST -------$2.58
DISK EXCPS -------------------64 @  $0.36 PER 1000 ------------0.02
           I/O COST (EXCLUDING PRINTER/READER/PUNCH) -------$0.02

TOTAL COST (AFTER       $0.78   2ND SHIFT DISCOUNT) ---------$1.82
```

S L A M S U M M A R Y R E P O R T

SIMULATION PROJECT CLINIC #20 BY BRADLEY

DATE 6/13/1985 RUN NUMBER 1 OF 4

CURRENT TIME 0.8621E+04
STATISTICAL ARRAYS CLEARED AT TIME 0.0000E+00

RANDOM NUMBER STREAMS

STREAM NUMBER	SEED VALUE
1	42895

FILE STATISTICS

FILE NUMBER	ASSOCIATED NODE TYPE	AVERAGE LENGTH	STANDARD DEVIATION	MAXIMUM LENGTH	CURRENT LENGTH	AVERAGE WAITING TIME
1	QUEUE	0.0815	0.2936	3	0	0.3705
2	CALENDAR	1.7009	0.4915	4	1	2.3927

REGULAR ACTIVITY STATISTICS

ACTIVITY INDEX	AVERAGE UTILIZATION	STANDARD DEVIATION	MAXIMUM UTILIZATION	CURRENT UTILIZATION	ENTITY COUNT
2	0.0000	0.0000	1	0	218
3	0.0000	0.0000	1	0	1500
4	0.0413	0.1991	2	0	178
5	0.0000	0.0000	1	0	178

SERVICE ACTIVITY STATISTICS

ACTIVITY INDEX	START NODE LABEL/TYPE	SERVER CAPACITY	AVERAGE UTILIZATION	STANDARD DEVIATION	CURRENT UTILIZATION	AVERAGE BLOCKAGE	MAXIMUM IDLE TIME/SERVERS	MAXIMUM BUSY TIME/SERVERS	ENTITY COUNT
1	QUE1 QUEUE	1	0.6597	0.4738	0	0.0000	4.8799	45.5430	1896

S L A M S U M M A R Y R E P O R T

SIMULATION PROJECT CLINIC #20 BY BRADLEY

DATE 6/13/1985 RUN NUMBER 2 OF 4

CURRENT TIME 0.8422E+04
STATISTICAL ARRAYS CLEARED AT TIME 0.0000E+00

RANDOM NUMBER STREAMS

STREAM NUMBER	SEED VALUE
1	79417

FILE STATISTICS

FILE NUMBER	ASSOCIATED NODE TYPE	AVERAGE LENGTH	STANDARD DEVIATION	MAXIMUM LENGTH	CURRENT LENGTH	AVERAGE WAITING TIME
1	QUEUE	0.1051	0.3369	4	0	0.4650
2	CALENDAR	2.7284	0.4912	5	3	3.6910

REGULAR ACTIVITY STATISTICS

ACTIVITY INDEX	AVERAGE UTILIZATION	STANDARD DEVIATION	MAXIMUM UTILIZATION	CURRENT UTILIZATION	ENTITY COUNT
2	0.0000	0.0000	1	0	202
3	0.0000	0.0000	1	0	1500
4	0.0480	0.2139	2	0	201
5	0.0000	0.0000	1	0	201

SERVICE ACTIVITY STATISTICS

ACTIVITY INDEX	START NODE LABEL/TYPE	SERVER CAPACITY	AVERAGE UTILIZATION	STANDARD DEVIATION	CURRENT UTILIZATION	AVERAGE BLOCKAGE	MAXIMUM IDLE TIME/SERVERS	MAXIMUM BUSY TIME/SERVERS	ENTITY COUNT
1	QUE1 QUEUE	1	0.6807	0.4662	1	0.0000	4.8320	55.8679	1903

S L A M S U M M A R Y R E P O R T

SIMULATION PROJECT CLINIC #20 BY BRADLEY

DATE 6/13/1985 RUN NUMBER 3 OF 4

CURRENT TIME 0.8403E+04
STATISTICAL ARRAYS CLEARED AT TIME 0.0000E+00

RANDOM NUMBER STREAMS

STREAM NUMBER	SEED VALUE
1	20049

FILE STATISTICS

FILE NUMBER	ASSOCIATED NODE TYPE	AVERAGE LENGTH	STANDARD DEVIATION	MAXIMUM LENGTH	CURRENT LENGTH	AVERAGE WAITING TIME
1	QUEUE	0.0857	0.3084	3	0	0.3863
2	CALENDAR	2.7103	0.4871	5	3	3.7657

REGULAR ACTIVITY STATISTICS

ACTIVITY INDEX	AVERAGE UTILIZATION	STANDARD DEVIATION	MAXIMUM UTILIZATION	CURRENT UTILIZATION	ENTITY COUNT
2	0.0000	0.0000	1	0	185
3	0.0000	0.0000	1	0	1500
4	0.0417	0.1998	1	0	179
5	0.0000	0.0000	1	0	179

SERVICE ACTIVITY STATISTICS

ACTIVITY INDEX	START NODE LABEL/TYPE	SERVER CAPACITY	AVERAGE UTILIZATION	STANDARD DEVIATION	CURRENT UTILIZATION	AVERAGE BLOCKAGE	MAXIMUM IDLE TIME/SERVERS	MAXIMUM BUSY TIME/SERVERS	ENTITY COUNT
1	QUE1 QUEUE	1	0.6689	0.4706	1	0.0000	4.9304	47.2070	1864

S L A M S U M M A R Y R E P O R T

SIMULATION PROJECT CLINIC #20 BY BRADLEY

DATE 6/13/1985 RUN NUMBER 4 OF 4

CURRENT TIME 0.8369E+04
STATISTICAL ARRAYS CLEARED AT TIME 0.0000E+00

RANDOM NUMBER STREAMS

STREAM NUMBER	SEED VALUE
1	63381

FILE STATISTICS

FILE NUMBER	ASSOCIATED NODE TYPE	AVERAGE LENGTH	STANDARD DEVIATION	MAXIMUM LENGTH	CURRENT LENGTH	AVERAGE WAITING TIME
1	QUEUE	0.0947	0.3120	3	0	0.4253
2	CALENDAR	2.7134	0.4936	5	2	3.7321

REGULAR ACTIVITY STATISTICS

ACTIVITY INDEX	AVERAGE UTILIZATION	STANDARD DEVIATION	MAXIMUM UTILIZATION	CURRENT UTILIZATION	ENTITY COUNT
2	0.0000	0.0000	1	0	163
3	0.0000	0.0000	1	0	1500
4	0.0496	0.2172	1	0	201
5	0.0000	0.0000	1	0	201

SERVICE ACTIVITY STATISTICS

ACTIVITY INDEX	START NODE LABEL/TYPE	SERVER CAPACITY	AVERAGE UTILIZATION	STANDARD DEVIATION	CURRENT UTILIZATION	AVERAGE BLOCKAGE	MAXIMUM IDLE TIME/SERVERS	MAXIMUM BUSY TIME/SERVERS	ENTITY COUNT
1	QUE1 QUEUE	1	0.6640	0.4723	0	0.0000	4.8784	60.0000	1864

```
GEN,BRADLEY,CLINIC # 20,6/14/85,4;
LIMITS,1,3,500;
PRIORITY/1,HVF(1);
SEEDS,633816299(1)/NO,1954324947(2)/NO,1145661099(3)/NO;
SEEDS,1835732737(4)/NO,794161987(5)/NO,1329531353(6)/NO;
SEEDS,200496737(7)/NO,428956417(8)/NO,1410143363(9)/NO;
SEEDS,1282538739(10)/NO;
NETWORK;
      CREATE,UNFRM(3,7);
QUE1  QUEUE(1);
          ACT/1,UNFRM(2,4);
      GOON,1;
          ACT/2,,.1,HOME;
          ACT/3,,.8,END;
          ACT/4,UNFRM(1,3),.1;
      ASSIGN,ATRIB(1)=1,1;
      GOON,1;
          ACT/5,,,QUE1;
HOME  TERMINATE;
END   TERMINATE,1500;
      ENDNETWORK;
SIMULATE;
FIN;
```

CPU TIME 9 MIN 49 SEC

RUN ON THE IBM PC

RANDOM NUMBER STREAMS

STREAM NUMBER	SEED VALUE	REINITIALIZATION OF STREAM
1	17643	NO
2	24109	NO
3	26283	NO
4	3841	NO
5	3261	NO
6	2521	NO
7	22113	NO
8	23297	NO
9	5251	NO
10	781	NO

1 RUN ON THE IBM PC

P C S L A M S U M M A R Y R E P O R T

SEEDS,20049(1)/YES;

SIMULATION PROJECT CLINIC # 20 BY BRADLEY

DATE 6/14/1985 RUN NUMBER 1 OF 4

CURRENT TIME .8417E+04
STATISTICAL ARRAYS CLEARED AT TIME .0000E+00

FILE STATISTICS

FILE NUMBER	ASSOCIATED NODE TYPE	AVERAGE LENGTH	STANDARD DEVIATION	MAXIMUM LENGTH	CURRENT LENGTH	AVERAGE WAIT TIME
1	QUEUE	.094	.308	2	0	.417
2	CALENDAR	1.726	.490	4	2	2.336

REGULAR ACTIVITY STATISTICS

ACTIVITY INDEX	AVERAGE UTILIZATION	STANDARD DEVIATION	MAXIMUM UTILIZATION	CURRENT UTILIZATION	ENTITY COUNT
2	.0000	.0000	1	0	198
3	.0000	.0000	1	0	1500
4	.0489	.2157	1	0	207
5	.0000	.0000	1	0	207

SERVICE ACTIVITY STATISTICS

ACT IND	START NODE LABEL/TYPE	SER CAP	AVERAGE UTIL	STD DEV	CUR UTIL	AVERAGE BLOCK	MAX IDL TME/SER	MAX BSY TME/SER	ENT CNT
1	QUE1 QUEUE	1	.677	.47	1	.00	4.84	52.40	1905

1

P C S L A M S U M M A R Y R E P O R T

SEEDS, 17643(1)/NO;

SIMULATION PROJECT CLINIC # 20 BY BRADLEY

DATE 6/14/1985 RUN NUMBER 1 OF 4

CURRENT TIME .8392E+04
STATISTICAL ARRAYS CLEARED AT TIME .0000E+00

FILE STATISTICS

FILE NUMBER	ASSOCIATED NODE TYPE	AVERAGE LENGTH	STANDARD DEVIATION	MAXIMUM LENGTH	CURRENT LENGTH	AVERAGE WAIT TIME
1	QUEUE	.108	.333	2	0	.480
2	CALENDAR	1.729	.489	4	1	2.357

REGULAR ACTIVITY STATISTICS

ACTIVITY INDEX	AVERAGE UTILIZATION	STANDARD DEVIATION	MAXIMUM UTILIZATION	CURRENT UTILIZATION	ENTITY COUNT
2	.0000	.0000	1	0	168
3	.0000	.0000	1	0	1500
4	.0502	.2184	1	0	211
5	.0000	.0000	1	0	211

SERVICE ACTIVITY STATISTICS

ACT IND	START NODE LABEL/TYPE	SER CAP	AVERAGE UTIL	STD DEV	CUR UTIL	AVERAGE BLOCK	MAX IDL TME/SER	MAX BSY TME/SER	ENT CNT
1	QUE1 QUEUE	1	.678	.47	0	.00	4.93	44.27	1879

```
**** TSO FOREGROUND HARDCOPY ****
DSNAME=U15799A.PROB20.GPSS.DATA

//U15799AA  JOB (15799,SSS-SS-SSSS),'BRADLEY',CLASS=F,                  00000010
//  TIME=(0,5),MSGCLASS=X,NOTIFY=U15799A                                00000020
/*PASSWORD ?                                                           00000030
/*JOBPARM FORMS=9001,ROOM=R,COPIES=1                                   00000040
//  EXEC GPSS                                                          00000050
//GPSS.SYSIN DD *                                                      00000060
*234567*9012345678*01234567890*                                        00000070
* CLINIC #20                                                          00000080
       SIMULATE                                                       00000090
       RMULT      42895                                               00000100
       GENERATE   5,2                                                 00000110
 QUE   QUEUE      LINE          WAIT FOR EXAMINATION                  00000120
       SEIZE      EXAM                                                00000130
       DEPART     LINE                                                00000140
       ADVANCE    3,1           RECEIVE EXAM                          00000150
       RELEASE    EXAM                                                00000160
       TRANSFER   .8,,PASS      80% PASS EXAM                         00000170
       TRANSFER   .5,,HOME      50% OF THE REST GO HOME               00000180
 SPR   ADVANCE    2,1           OTHERS NEED A SIMPLE PROCEEDURE       00000190
       PRIORITY   1             GO TO HEAD OF LINE                    00000200
       TRANSFER   ,QUE          RETURN FOR REEXAMINATION              00000210
 HOME  TERMINATE                NOT CONSIDERED PASSED IF SENT HOME    00000220
 PASS  TERMINATE  1                                                   00000230
       START      1500          SIMULATE FOR 1500 PATIENTS            00000240
       RMULT      79416                                               00000250
       CLEAR                                                          00000260
       START      1500                                                00000270
       RMULT      20049                                               00000280
       CLEAR                                                          00000290
       START      1500                                                00000300
       RMULT      63381                                               00000310
       CLEAR                                                          00000320
       START      1500                                                00000330
       END                                                            00000340
//                                                                    00000350
```

```
                                                  CPU     0MIN 02.09SEC
-------------------------------------------------------------------------
PROCESSOR TIME ---------0.00067 CPU HOURS @ $1,135.00 --------0.76
PROCESSOR STORAGE ------0.12076 K-BYTE HOURS @   $0.25 --------0.03
                                    TOTAL PROCESSOR COST -------$0.79
GPSS
DISK EXCPS -----------------216 @  $0.36 PER 1000 ------------0.08
                I/O COST (EXCLUDING PRINTER/READER/PUNCH) -------$0.08

TOTAL COST (AFTER       $0.26   2ND SHIFT DISCOUNT) ---------$0.61
```

RELATIVE CLOCK 8554 ABSOLUTE CLOCK 8554 RMULT 42895

BLOCK COUNTS

BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL
1	0	1704	11	0	185									
2	0	1889	12	0	204									
3	0	1889	13	0	1500									
4	0	1889												
5	0	1889												
6	0	1889												
7	0	1889												
8	0	389												
9	0	185												
10	0	185												

FACILITIES

FACILITY	NUMBER ENTRIES	AVERAGE TIME/TRAN	-AVERAGE TOTAL TIME	UTILIZATION DURING- AVAIL. TIME	UNAVAIL. TIME	CURRENT STATUS	PERCENT AVAILABILITY	TRANSACTION NUMBER SEIZING	PREEMPTING
EXAM	1889	2.984	.658				100.0		

QUEUES

QUEUE	MAXIMUM CONTENTS	AVERAGE CONTENTS	TOTAL ENTRIES	ZERO ENTRIES	PERCENT ZEROS	AVERAGE TIME/TRANS	$AVERAGE TIME/TRANS	TABLE NUMBER	CURRENT CONTENTS
LINE	3	.106	1889	1451	76.8	.480	2.073		

$AVERAGE TIME/TRANS = AVERAGE TIME/TRANS EXCLUDING ZERO ENTRIES

RELATIVE CLOCK 8374 ABSOLUTE CLOCK 8374 RMULT 79416

BLOCK COUNTS

BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL
1	0	1697	11	0	191									
2	1	1888	12	0	196									
3	0	1887	13	0	1500									
4	0	1887												
5	0	1887												
6	0	1887												
7	0	1887												
8	0	387												
9	0	191												
10	0	191												

FACILITIES

FACILITY	NUMBER ENTRIES	AVERAGE TIME/TRAN	-AVERAGE UTILIZATION DURING- TOTAL TIME	AVAIL. TIME	UNAVAIL. TIME	CURRENT STATUS	PERCENT AVAILABILITY	TRANSACTION NUMBER SEIZING	PREEMPTING
EXAM	1887	2.957	.666				100.0		

QUEUES

QUEUE	MAXIMUM CONTENTS	AVERAGE CONTENTS	TOTAL ENTRIES	ZERO ENTRIES	PERCENT ZEROS	AVERAGE TIME/TRANS	$AVERAGE TIME/TRANS	TABLE NUMBER	CURRENT CONTENTS
LINE	4	.115	1888	1442	76.3	.513	2.172		1

$AVERAGE TIME/TRANS = AVERAGE TIME/TRANS EXCLUDING ZERO ENTRIES

RELATIVE CLOCK 8395 ABSOLUTE CLOCK 8395 RMULT 20049

BLOCK COUNTS

BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL
1	0	1684	11	0	175									
2	1	1859	12	0	183									
3	0	1858	13	0	1500									
4	0	1858												
5	0	1858												
6	0	1858												
7	0	1858												
8	0	358												
9	0	175												
10	0	175												

FACILITIES

FACILITY	NUMBER ENTRIES	AVERAGE TIME/TRAN	-AVERAGE TOTAL TIME	UTILIZATION DURING- AVAIL. TIME	UNAVAIL. TIME	CURRENT STATUS	PERCENT AVAILABILITY	TRANSACTION NUMBER SEIZING	PREEMPTING
EXAM	1858	3.014	.667				100.0		

QUEUES

QUEUE	MAXIMUM CONTENTS	AVERAGE CONTENTS	TOTAL ENTRIES	ZERO ENTRIES	PERCENT ZEROS	AVERAGE TIME/TRANS	$AVERAGE TIME/TRANS	TABLE NUMBER	CURRENT CONTENTS
LINE	3	.102	1859	1436	77.2	.462	2.033		1

$AVERAGE TIME/TRANS = AVERAGE TIME/TRANS EXCLUDING ZERO ENTRIES

RELATIVE CLOCK 8326 ABSOLUTE CLOCK 8326 RMULT 63381

BLOCK COUNTS

BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL
1	0	1683	11	0	187									
2	0	1870	12	0	183									
3	0	1870	13	0	1500									
4	0	1870												
5	0	1870												
6	0	1870												
7	0	1870												
8	0	370												
9	0	187												
10	0	187												

FACILITIES

FACILITY	NUMBER ENTRIES	AVERAGE TIME/TRAN	-AVERAGE TOTAL TIME	UTILIZATION DURING- AVAIL. TIME	UNAVAIL. TIME	CURRENT STATUS	PERCENT AVAILABILITY	TRANSACTION NUMBER SEIZING	PREEMPTING
EXAM	1870	3.022	.678				100.0		

QUEUES

QUEUE	MAXIMUM CONTENTS	AVERAGE CONTENTS	TOTAL ENTRIES	ZERO ENTRIES	PERCENT ZEROS	AVERAGE TIME/TRANS	$AVERAGE TIME/TRANS	TABLE NUMBER	CURRENT CONTENTS
LINE	3	.128	1870	1377	73.6	.570	2.162		

$AVERAGE TIME/TRANS = AVERAGE TIME/TRANS EXCLUDING ZERO ENTRIES

BANK #21

Consider a bank with four tellers. Tellers 3 and 4 deal only with business accounts, while Tellers 1 and 2 deal with general accounts. Clients arrive at the bank at a rate of one every 3 + or - 1 minutes. Of the clients, 33% are business accounts. Clients randomly choose between the two tellers available for each type of account. (Assume that a customer chooses a line without regard to its length and does not change lines.) Business accounts take 15 + or - 10 minutes to complete and general accounts take 6 + or - 5 minutes to complete. Simulate the system for 500 transactions to be completed. What percentage of time is each type of teller busy? What is the average time that each type of customer spends in the bank?

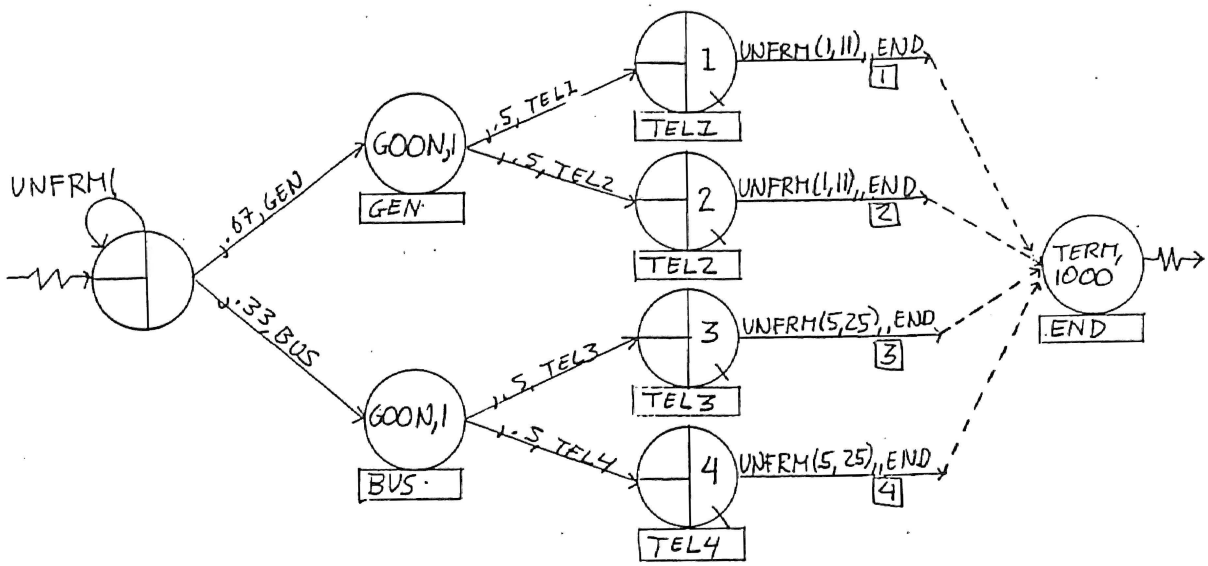
ANALYSIS OF SLAM, PC SLAM, AND GPSS RUNS

	SLAM	GPSS	PC SLAM
Avg. Time Teller 1 Busy:	.6308	.682	.619
Avg. Wait for Teller 1 :	3.2605	4.273	4.852
Customers Served :	475	519	473
Avg. Time Teller 2 Busy:	.7242	.661	.703
Avg. Wait for Teller 2 :	7.6033	3.847	6.433
Customers Served :	534	498	538
Avg. Time Teller 3 Busy:	.8230	.794	.787
Avg. Wait for Teller 3 :	23.1363	37.592	24.082
Customers Served :	257	239	236
Avg. Time Teller 4 Busy:	.7995	.857	.855
Avg. Wait for Teller 4 :	41.5275	42.323	39.204
Customers Served :	234	247	253
Total System Run Time :	4824 min.	4482 min.	4491 min.

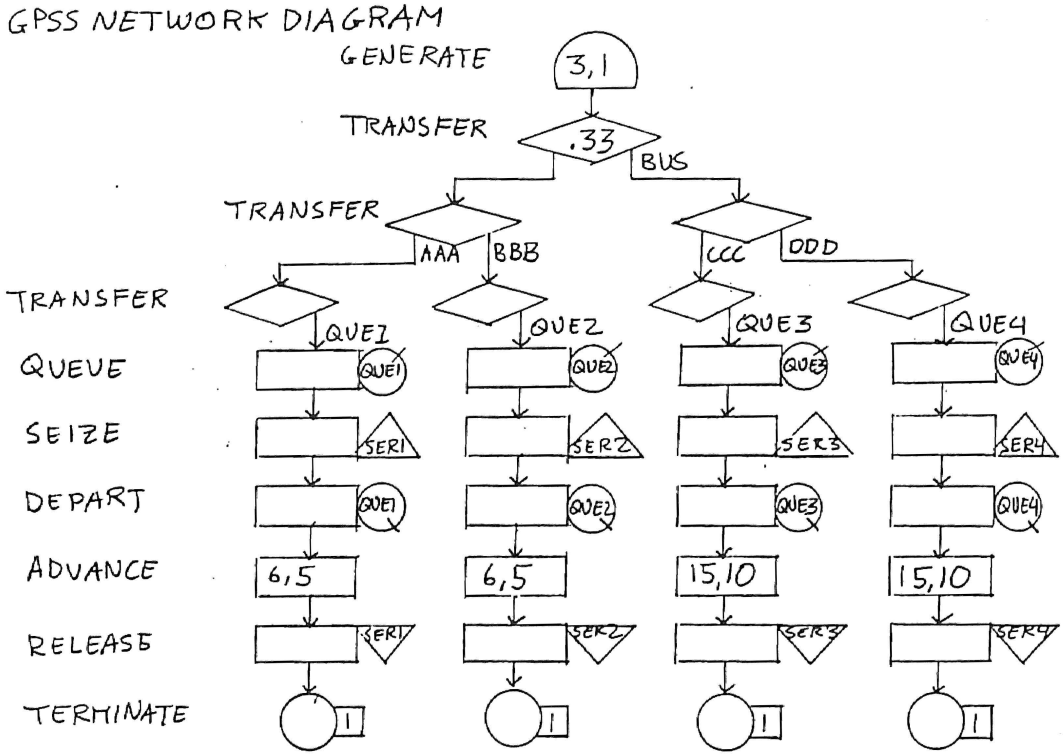
Again, as in the previous models, the GPSS and SLAM data are comparable. The most noteworthy part of this model is the results themselves: if a bank has an average wait time of 23 to 42 minutes for its business customers, it had better consider adding another business teller, or risk losing business customers.

SLAM NETWORK DIAGRAM

BANK #21



GPSS NETWORK DIAGRAM



```
 1  GEN,BRADLEY,BANK #21,6/2/85,1;
 2  LIMITS,4,0,500;
 3  NETWORK;
 4        CREATE,UNFRM(2,4);
 5             ACT,,.67,GEN;              67% ARE GENERAL CUSTOMERS
 6             ACT,,.33,BUS;              33% ARE BUSINESS CUSTOMERS
 7  GEN    GOON,1;
 8             ACT,,.5,TEL1;              CHOOSE EQUALLY BETWEEN
 9             ACT,,.5,TEL2;                   GENERAL TELLERS
10  TEL1   QUEUE(1);                     TELLER 1
11             ACT/1,UNFRM(1,11),,END;
12  TEL2   QUEUE(2);                     TELLER 2
13             ACT/2,UNFRM(1,11),,END;
14  BUS    GOON,1;
15             ACT,,.5,TEL3;              CHOOSE EQUALLY BETWEEN
16             ACT,,.5,TEL4;                   BUSINESS TELLERS
17  TEL3   QUEUE(3);                     TELLER 3
18             ACT/3,UNFRM(5,25),,END;
19  TEL4   QUEUE(4);                     TELLER 4
20             ACT/4,UNFRM(5,25),,END;
21  END    TERM,1500;                    SIMULATE FOR 1500 CUSTOMERS
22        ENDNETWORK;
23  FIN;
```

```
                                                        CPU     0MIN 02.04SEC
-------------------------------------------------------------------------------
PROCESSOR TIME ---------0.00066 CPU HOURS @ $1,135.00 --------0.75
PROCESSOR STORAGE ------0.39893 K-BYTE HOURS @  $0.25 --------0.10
SLAM                                  TOTAL PROCESSOR COST -------$0.85
DISK EXCPS ------------------51 @  $0.36 PER 1000 ------------0.02
                  I/O COST (EXCLUDING PRINTER/READER/PUNCH) -------$0.02

TOTAL COST (AFTER       $0.52   3RD SHIFT DISCOUNT) ---------$0.35
```

S L A M S U M M A R Y R E P O R T

SIMULATION PROJECT BANK #21 BY BRADLEY

DATE 6/ 2/1985 RUN NUMBER 1 OF 1

CURRENT TIME 0.4524E+04
STATISTICAL ARRAYS CLEARED AT TIME 0.0000E+00

FILE STATISTICS

FILE NUMBER	ASSOCIATED NODE TYPE	AVERAGE LENGTH	STANDARD DEVIATION	MAXIMUM LENGTH	CURRENT LENGTH	AVERAGE WAITING TIME
1	QUEUE	0.3430	0.6630	4	0	3.2605
2	QUEUE	0.8991	1.3809	7	0	7.6033
3	QUEUE	1.3141	1.5466	6	0	23.1326
4	QUEUE	2.1570	3.0894	14	0	41.5275
5	CALENDAR	3.9768	0.7319	6	4	2.5633

SERVICE ACTIVITY STATISTICS

ACTIVITY INDEX	START NODE LABEL/TYPE	SERVER CAPACITY	AVERAGE UTILIZATION	STANDARD DEVIATION	CURRENT UTILIZATION	AVERAGE BLOCKAGE	MAXIMUM IDLE TIME/SERVERS	MAXIMUM BUSY TIME/SERVERS	ENTITY COUNT
1	TEL1 QUEUE	1	0.6308	0.4826	1	0.0000	40.3877	77.2124	475
2	TEL2 QUEUE	1	0.7242	0.4469	1	0.0000	36.4915	242.3201	534
3	TEL3 QUEUE	1	0.8230	0.3817	0	0.0000	59.1250	546.9990	257
4	TEL4 QUEUE	1	0.7995	0.4004	1	0.0000	54.7986	1350.5925	234

P C S L A M S U M M A R Y R E P O R T

BANK #21

CPU TIME: 10 MIN 00 SEC
TOTAL TIME TO RUN MODEL: 16 MIN 20 SEC

SIMULATION PROJECT BANK #21 BY BRADLEY

DATE 6/27/1985 RUN NUMBER 1 OF 1

CURRENT TIME .4491E+04
STATISTICAL ARRAYS CLEARED AT TIME .0000E+00

FILE STATISTICS

FILE NUMBER	ASSOCIATED NODE TYPE	AVERAGE LENGTH	STANDARD DEVIATION	MAXIMUM LENGTH	CURRENT LENGTH	AVERAGE WAIT TIME
1	QUEUE	.511	1.009	7	0	4.852
2	QUEUE	.774	1.320	8	1	6.433
3	QUEUE	1.276	1.916	10	1	24.082
4	QUEUE	2.209	2.213	11	0	39.204
5	CALENDAR	3.963	.716	6	3	2.536

SERVICE ACTIVITY STATISTICS

ACT IND	START NODE LABEL/TYPE	SER CAP	AVERAGE UTIL	STD DEV	CUR UTIL	AVERAGE BLOCK	MAX IDL TME/SER	MAX BSY TME/SER	ENT CNT
1	TEL1 QUEUE	1	.619	.49	0	.00	52.49	142.06	473
2	TEL2 QUEUE	1	.703	.46	1	.00	39.24	215.25	538
3	TEL3 QUEUE	1	.787	.41	1	.00	109.80	873.12	236
4	TEL4 QUEUE	1	.855	.35	0	.00	106.45	985.26	253

```
                                                                                                             CPU     OMIN 00.67SEC
                                                                        ----------------------------------------------------------------------
                                                                        PROCESSOR TIME ---------0.00028 CPU HOURS @ $1,135.00 --------0.32
                                                                        PROCESSOR STORAGE ------0.03871 K-BYTE HOURS @  $0.25 --------0.01
                                                                        GPSS                               TOTAL PROCESSOR COST -------$0.33
BLOCK
NUMBER  *LOC    OPERATION  A,B,C,D,E,F,G,H,I           COMMENTS        DISK EXCPS -----------------198 @  $0.36 PER 1000 ------------0.07
        * BANK  #21                                                                I/O COST (EXCLUDING PRINTER/READER/PUNCH) -------$0.07
                SIMULATE
1               GENERATE   3,1         ONE CUSTOMER EVERY 3 MIN +OR- 1 MIN  TOTAL COST (AFTER       $0.24   3RD SHIFT DISCOUNT) ---------$0.16
2               TRANSFER   .33,,BUS    33% ARE BUSINESS CUSTOMERS
3               TRANSFER   PICK,AAA,BBB     CHOOSE EQUALLY QUE1 OR QUE2
4        AAA    TRANSFER   ,QUE1
5        BBB    TRANSFER   ,QUE2
6        QUE1   QUEUE      QUE1        GENERAL ACCOUNT TELLER
7               SEIZE      SER1
8               DEPART     QUE1
9               ADVANCE    6,5
10              RELEASE    SER1
11              TERMINATE  1
12       QUE2   QUEUE      QUE2
13              SEIZE      SER2
14              DEPART     QUE2
15              ADVANCE    6,5
16              RELEASE    SER2
17              TERMINATE  1
18       BUS    TRANSFER   PICK,CCC,DDD     CHOOSE EQUALLY QUE3 OR QUE4
19       CCC    TRANSFER   ,QUE3
20       DDD    TRANSFER   ,QUE4
21       QUE3   QUEUE      QUE3        BUSINESS ACCOUNT TELLER
22              SEIZE      SER3
23              DEPART     QUE3
24              ADVANCE    15,10
25              RELEASE    SER3
26              TERMINATE  1
27       QUE4   QUEUE      QUE4
28              SEIZE      SER4
29              DEPART     QUE4
30              ADVANCE    15,10
31              RELEASE    SER4
32              TERMINATE  1
                START      1500        SIMULATE FOR 1500 CUSTOMERS
                END
```

RELATIVE CLOCK 4482 ABSOLUTE CLOCK 4482

BLOCK COUNTS

BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL
1	0	1510	11	0	518	21	4	243	31	0	246			
2	0	1510	12	0	498	22	0	239	32	0	246			
3	0	1017	13	0	498	23	0	239						
4	0	519	14	0	498	24	0	239						
5	0	498	15	1	498	25	0	239						
6	0	519	16	0	497	26	0	239						
7	0	519	17	0	497	27	3	250						
8	0	519	18	0	493	28	0	247						
9	1	519	19	0	243	29	0	247						
10	0	518	20	0	250	30	1	247						

FACILITIES

FACILITY	NUMBER ENTRIES	AVERAGE TIME/TRAN	-AVERAGE TOTAL TIME	UTILIZATION DURING- AVAIL. TIME	UNAVAIL. TIME	CURRENT STATUS	PERCENT AVAILABILITY	TRANSACTION NUMBER SEIZING	PREEMPTING
SER1	519	5.890	.682				100.0	1	
SER2	498	5.950	.661				100.0	14	
SER3	239	14.891	.794				100.0		
SER4	247	15.563	.857				100.0	6	

QUEUES

QUEUE	MAXIMUM CONTENTS	AVERAGE CONTENTS	TOTAL ENTRIES	ZERO ENTRIES	PERCENT ZEROS	AVERAGE TIME/TRANS	$AVERAGE TIME/TRANS	TABLE NUMBER	CURRENT CONTENTS
QUE1	4	.494	519	218	42.0	4.273	7.368		
QUE2	4	.427	498	229	45.9	3.847	7.122		
QUE3	11	2.038	243	47	19.3	37.592	46.607		4
QUE4	11	2.360	250	41	16.3	42.323	50.626		3

$AVERAGE TIME/TRANS = AVERAGE TIME/TRANS EXCLUDING ZERO ENTRIES

END

***** TOTAL RUN TIME (INCLUDING ASSEMBLY) = .01 MINUTES *****

DATA PROCESSING #32

Go Ape! buys a Banana II computer to handle all of its data processing needs. Jobs arrive every 10 + or - 10 minutes to be batch processed one at a time. Processing takes 7 + or - 7 minutes. The monkeys that run their computer cause a system failure every 60 + or - 60 minutes. The failure lasts for 8 + or - 4 minutes. When a failure occurs, the job that was being run resumes processing where it was left off. Simulate the operation of this system for 24 hours. Estimate the mean system response time. (A system response time is the length of time from arrival until processing is completed.) Also estimate the mean delay for those jobs that are in service when a computer system failure occurs.

ANALYSIS OF SLAM AND GPSS RUNS

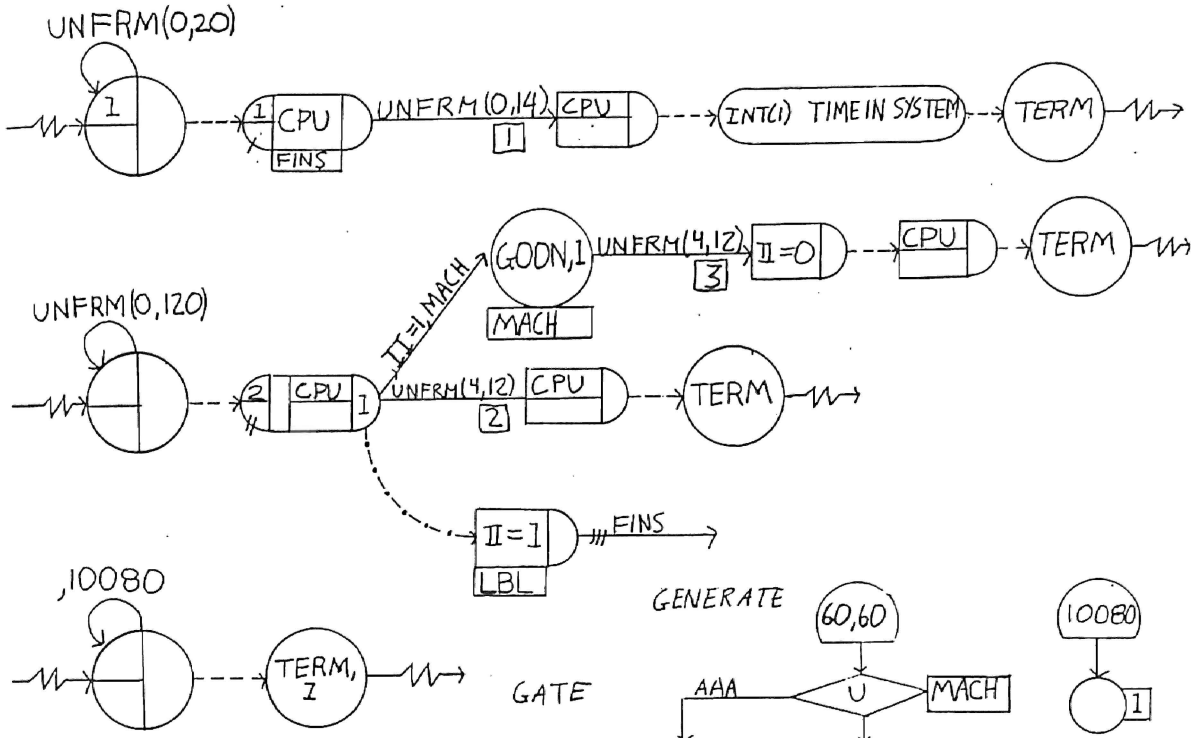
	SLAM	GPSS
Mean Response Time:	22.68	22.64
Mean Failure Delay:	7.69	7.98

This model is more a test of the uniform distribution functions of SLAM and GPSS than anything. The delay due to a computer failure is 8 + or - 4 minutes. Thus the closer the mean failure delay is to 8 the better. SLAM recorded a value of 7.69, and GPSS a value of 7.98. Due to differences in the pseudorandom number streams, and the fact that this is a sample of one, it can not be concluded that GPSS has can "better" approximate a uniform distribution than SLAM.

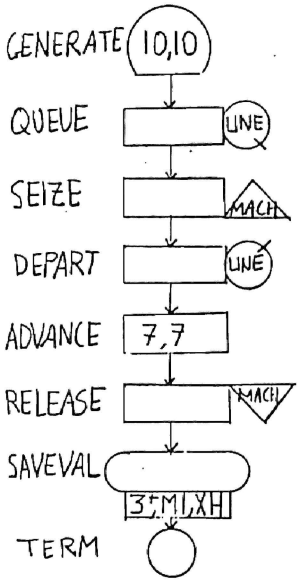
The mean response times were extremely close in this model. The SLAM coding, using RESOURCEs, is directly analogous to the GPSS, where an entity may SEIZE or RELEASE a FACILITY. It is possible that the results were so close in part due to the similar structure of the coding.

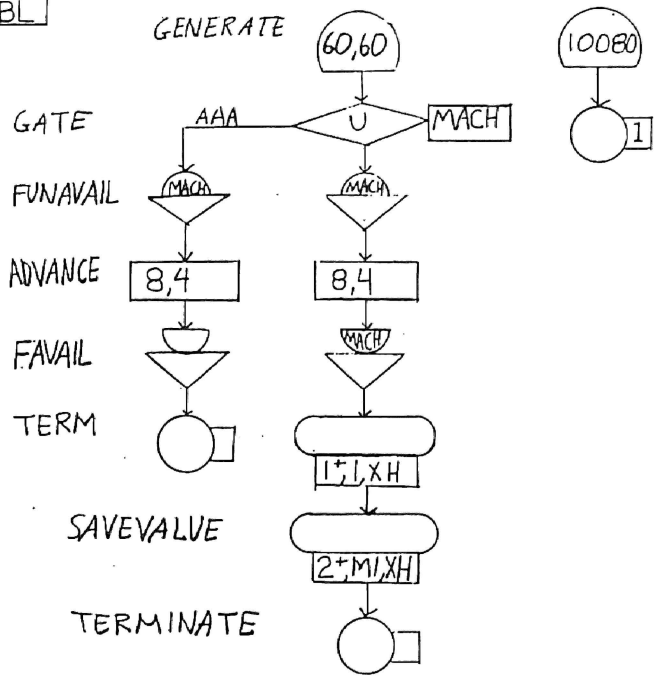
SLAM NETWORK DIAGRAM

DATA PROCESSING #32



GPSS NETWORK DIAGRAM





```
 1  GEN,BRADLEY,DATA PROCESSING #32,6/2/85,1;
 2  LIMITS,2,1,500;
 3  NETWORK;
 4        RESOURCE/CPU(1),2,1;
 5  ; SIMULATE RUNNING JOBS IN SYSTEM
 6        CREATE,UNFRM(0,20),,1;
 7  FINS  AWAIT(1),CPU;
 8            ACT/1,UNFRM(0,14);
 9        FREE,CPU;
10        COLCT,INT(1),TIME IN SYSTEM;
11        TERM;
12  ; SIMULATE DOWNTIME, NO ENTITY PREEMPTED
13        CREATE,UNFRM(0,120);
14        PREEMPT(2),CPU,LBL;
15            ACT,,II.EQ.1,MACH;
16            ACT/2,UNFRM(4,12),II.EQ.0;
17        FREE,CPU;
18        TERM;
19  ; SIMULATE DOWNTIME, ENTITY PREEMPTED
20  MACH  GOON,1;
21            ACT/3,UNFRM(4,12);          STATS GIVE # ENTITIES PREEMPTED
22        ASSIGN,II=0;
23        FREE,CPU;
24        TERM;
25  ; DETERMINE IF AN ENTITY HAS BEEN PREEMPTED
26  LBL   ASSIGN,II=1;
27        ACT,,,FINS;
28  ; SIMULATE FOR 24 HOURS/DAY, 7 DAYS (IN MINUTES)
29        CREATE,,10080;
30        TERM,1;
31        ENDNETWORK;
32  FIN;
```

```
                                                    CPU     0MIN 01.93SEC
-------------------------------------------------------------------------------
PROCESSOR TIME ---------0.00063 CPU HOURS @ $1,135.00 --------0.72
PROCESSOR STORAGE ------0.37742 K-BYTE HOURS @  $0.25 --------0.09
SLAM                             TOTAL PROCESSOR COST -------$0.81

DISK EXCPS -------------------59 @  $0.36 PER 1000 ------------0.02
           I/O COST (EXCLUDING PRINTER/READER/PUNCH) -------$0.02

TOTAL COST (AFTER       $0.50   3RD SHIFT DISCOUNT) ---------$0.33
```

S L A M S U M M A R Y R E P O R T

SIMULATION PROJECT DATA PROCESSING #32 BY BRADLEY

DATE 6/ 2/1985 RUN NUMBER 1 OF 1

CURRENT TIME 0.1008E+05
STATISTICAL ARRAYS CLEARED AT TIME 0.0000E+00

STATISTICS FOR VARIABLES BASED ON OBSERVATION

	MEAN VALUE	STANDARD DEVIATION	COEFF. OF VARIATION	MINIMUM VALUE	MAXIMUM VALUE	NUMBER OF OBSERVATIONS
TIME IN SYSTEM	0.2268E+02	0.1878E+02	0.8283E+00	0.1172E-01	0.1278E+03	969

FILE STATISTICS

FILE NUMBER	ASSOCIATED NODE TYPE	AVERAGE LENGTH	STANDARD DEVIATION	MAXIMUM LENGTH	CURRENT LENGTH	AVERAGE WAITING TIME
1	AWAIT	1.4792	1.7545	9	2	13.4696
2	PREEMPT	0.0035	0.0587	1	0	0.2017
3	CALENDAR	3.8414	0.3657	5	3	7.4594

REGULAR ACTIVITY STATISTICS

ACTIVITY INDEX	AVERAGE UTILIZATION	STANDARD DEVIATION	MAXIMUM UTILIZATION	CURRENT UTILIZATION	ENTITY COUNT
1	0.7055	0.4558	1	1	969
2	0.0788	0.2695	1	0	98
3	0.0572	0.2322	1	0	75

RESOURCE STATISTICS

RESOURCE NUMBER	RESOURCE LABEL	CURRENT CAPACITY	AVERAGE UTILIZATION	STANDARD DEVIATION	MAXIMUM UTILIZATION	CURRENT UTILIZATION
1	CPU	1	0.8416	0.3652	1	1

RESOURCE NUMBER	RESOURCE LABEL	CURRENT AVAILABLE	AVERAGE AVAILABLE	MINIMUM AVAILABLE	MAXIMUM AVAILABLE
1	CPU	0	0.1584	0	1

```
BLOCK
NUMBER   *LOC    OPERATION  A,B,C,D,E,F,G,H,I          COMMENTS
         *234567*9012345678*01234567890*
         * DATA PROCESSING #32
                SIMULATE
         * SIMULATE RUNNING JOBS IN COMPUTER SYSTEM
1                GENERATE   10,10        ONE JOB EVERY 10 MIN +OR- 10
2                QUEUE      LINE
3                SEIZE      MACH
4                DEPART     LINE
5                ADVANCE    7,7          TIME FOR PROCESSING JOB
6                RELEASE    MACH
7                SAVEVALUE  3+,M1,XH     M1 IS TIME IN TRANSIT OF JOB
8                TERMINATE
         * SIMULATE DOWNTIME
9                GENERATE   60,60        COMPUTER FAILURE EVERY 60 MIN +OR- 60
10               GATE U     MACH,AAA     IF MACH IN USE, ENTITY PROCEEDS
11               FUNAVAIL   MACH
12               ADVANCE    8,4          DOWNTIME DUE TO COMPUTER FAILURE
13               FAVAIL     MACH
14               SAVEVALUE  1+,1,XH      COUNT # OF JOBS INTERRUPTED
15               SAVEVALUE  2+,M1,XH     M1 IS DOWNTIME, ADDED TO SAVEVALUE #2
16               TERMINATE
17        AAA    FUNAVAIL   MACH         IF MACH NOT IN USE, ENTITY GOES HERE
18               ADVANCE    8,4
19               FAVAIL     MACH
20               TERMINATE
         * SIMULATE FOR 24 HOURS/DAY, 7 DAYS (IN MINUTES)
21               GENERATE   10080
22               TERMINATE  1
                 START      1            SIMULATE FOR ONE WEEK OF USE
                 END
```

```
                                                    CPU     0MIN 00.52SEC
-------------------------------------------------------------------------
PROCESSOR TIME ---------0.00024 CPU HOURS @ $1,135.00 --------0.27
PROCESSOR STORAGE ------0.03004 K-BYTE HOURS @  $0.25 --------0.01
GPSS                                TOTAL PROCESSOR COST -------$0.28
DISK EXCPS ------------------179 @  $0.36 PER 1000 ------------0.06
                I/O COST (EXCLUDING PRINTER/READER/PUNCH) -------$0.06

TOTAL COST (AFTER       $0.20   3RD SHIFT DISCOUNT) ---------$0.14
```

```
RELATIVE CLOCK          10080  ABSOLUTE CLOCK          10080
BLOCK COUNTS
BLOCK CURRENT    TOTAL     BLOCK CURRENT    TOTAL     BLOCK CURRENT    TOTAL     BLOCK CURRENT    TOTAL     BLOCK CURRENT    TOTAL
    1       0     1010        11       0      129        21       0        1
    2       1     1010        12       0      129        22       0        1
    3       0     1009        13       0      129
    4       0     1009        14       0      129
    5       1     1009        15       0      129
    6       0     1008        16       0      129
    7       0     1008        17       0       47
    8       0     1008        18       0       47
    9       0      176        19       0       47
   10       0      176        20       0       47
```

FACILITIES

FACILITY	NUMBER ENTRIES	AVERAGE TIME/TRAN	-AVERAGE UTILIZATION DURING- TOTAL TIME	AVAIL. TIME	UNAVAIL. TIME	CURRENT STATUS	PERCENT AVAILABILITY	TRANSACTION NUMBER SEIZING	PREEMPTING
MACH	1009	6.985	.699	.801	.000	A	87.2	2	

QUEUES

QUEUE	MAXIMUM CONTENTS	AVERAGE CONTENTS	TOTAL ENTRIES	ZERO ENTRIES	PERCENT ZEROS	AVERAGE TIME/TRANS	$AVERAGE TIME/TRANS	TABLE NUMBER	CURRENT CONTENTS
LINE	10	1.480	1010	264	26.1	14.772	20.000		1

$AVERAGE TIME/TRANS = AVERAGE TIME/TRANS EXCLUDING ZERO ENTRIES

HALFWORD SAVEVALUES

NUMBER	CONTENTS	NUMBER	CONTENTS	NUMBER	CONTENTS	NUMBER	CONTENTS	NUMBER	CONTENTS	NUMBER	CONTENTS
1	129	2	1030	3	22822						

END

***** TOTAL RUN TIME (INCLUDING ASSEMBLY) = .00 MINUTES *****

SONIC DRIVE IN #33

Able, Baker, and Charlie are three carhops at the Sonic Drive In (service at the speed of sound!). Cars arrive every 5 + or - 5 minutes. The carhops service customers at the rate of one every 10 + or - 6 minutes. However, the customers prefer Able over Baker, and Baker over Charlie. If the carhop of choice is busy, the customers choose the first available carhop. Simulate the system for 2000 service completions. Estimate Able's, Baker's, and Charlie's utilization (percentage of time busy).

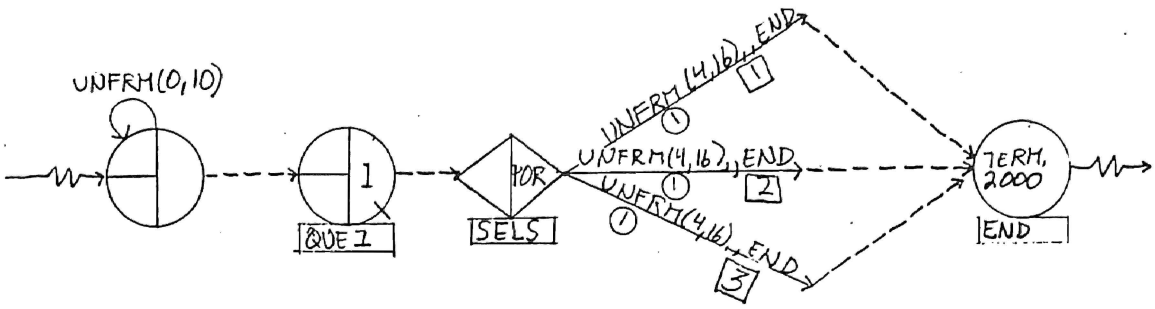
ANALYSIS OF SLAM AND GPSS RUNS

	SLAM	GPSS
Total System Run Time:	10150 min.	10008 min.
Able's Utilization :	.8040	.799
Baker's Utilization :	.6813	.697
Charlie's Utilization:	.4817	.505
Avg. Wait for Service:	.6222 min.	1.012 min.

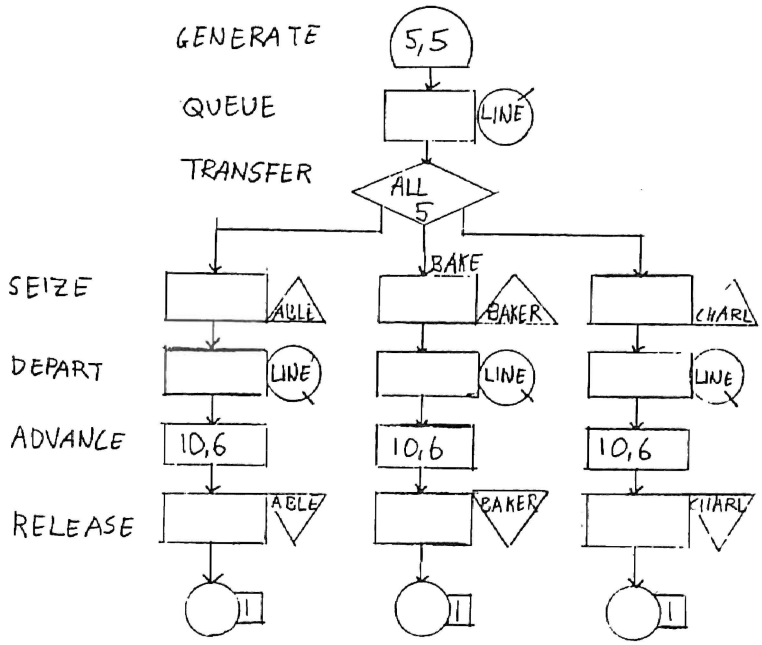
The results are quite similar. A run of 2000 entities was used. One reason that the SLAM and GPSS output is closer than that of previous models is due to the length of time the system was run. Longer run times, or more entities used, will tend to smooth out the random variations caused by different pseudorandom number streams. With identical models, two systems run with different number streams should converge as the length of the run is increased.

SLAM NETWORK DIAGRAM

SONIC DRIVE IN #33



GPSS NETWORK DIAGRAM



```
  1  GEN,BRADLEY,SONIC DRIVE IN #33,5/29/85,1;
  2  LIMITS,1,0,500;
  3  NETWORK;
  4        CREATE,UNFRM(0,10);
  5  QUE1  QUEUE(1),,,,SELS                WAIT FOR SERVICE
  6  SELS  SELECT,,POR,,QUE1;              SELECT PRIORITY
  7              ACT/1,UNFRM(4,16),,END;   FIRST CHOICE
  8              ACT/2,UNFRM(4,16),,END;   SECOND CHOICE
  9              ACT/3,UNFRM(4,16),,END;   THIRD CHOICE
 10  END   TERM,2000;                      END AFTER 2,000 CUSTOMERS
 11        ENDNETWORK;
 12  FIN;
```

```
                                                        CPU     0MIN 01.49SEC
-------------------------------------------------------------------------------
PROCESSOR TIME ---------0.00051 CPU HOURS @ $1,135.00 --------0.58
PROCESSOR STORAGE ------0.29138 K-BYTE HOURS @  $0.25 --------0.07
SLAM                                  TOTAL PROCESSOR COST -------$0.65
DISK EXCPS -------------------48 @  $0.36 PER 1000 ------------0.01
                  I/O COST (EXCLUDING PRINTER/READER/PUNCH) -------$0.01

TOTAL COST -----------------------------------------------------$0.66
```

S L A M S U M M A R Y R E P O R T

SIMULATION PROJECT SONIC DRIVE IN #33 BY BRADLEY

DATE 5/29/1985 RUN NUMBER 1 OF 1

CURRENT TIME 0.1015E+05
STATISTICAL ARRAYS CLEARED AT TIME 0.0000E+00

FILE STATISTICS

FILE NUMBER	ASSOCIATED NODE TYPE	AVERAGE LENGTH	STANDARD DEVIATION	MAXIMUM LENGTH	CURRENT LENGTH	AVERAGE WAITING TIME
1	QUEUE	0.1226	0.4098	4	0	0.6222
2	CALENDAR	2.9667	0.8551	5	1	6.8220

SERVICE ACTIVITY STATISTICS

ACTIVITY INDEX	START NODE LABEL/TYPE	SERVER CAPACITY	AVERAGE UTILIZATION	STANDARD DEVIATION	CURRENT UTILIZATION	AVERAGE BLOCKAGE	MAXIMUM IDLE TIME/SERVERS	MAXIMUM BUSY TIME/SERVERS	ENTITY COUNT
1	SELS SELECT	1	0.8040	0.3970	0	0.0000	9.6162	62.0535	816
2	SELS SELECT	1	0.6813	0.4660	0	0.0000	44.0742	59.2898	693
3	SELS SELECT	1	0.4817	0.4997	0	0.0000	137.0708	59.0305	491

```
BLOCK
NUMBER   *LOC    OPERATION  A,B,C,D,E,F,G,H,I          COMMENTS
         * SONIC DRIVE IN #33
                SIMULATE
1               GENERATE   5,5           ONE CUSTOMER EVERY 5 MIN +OR- 5
2               QUEUE      LINE          CUSTOMERS ENTER QUEUE
3               TRANSFER   ALL,ABE,CHAS,5      SELECT PRIORITY
4         ABE   SEIZE      ABLE          FIRST CHOICE
5               DEPART     LINE
6               ADVANCE    10,6          SERVICE TIME
7               RELEASE    ABLE
8               TERMINATE  1             LEAVE SYSTEM
9         BAKE  SEIZE      BAKER         SECOND CHOICE
10              DEPART     LINE
11              ADVANCE    10,6
12              RELEASE    BAKER
13              TERMINATE  1
14        CHAS  SEIZE      CHARL         THIRD CHOICE
15              DEPART     LINE
16              ADVANCE    10,6
17              RELEASE    CHARL
18              TERMINATE  1
                START      2000          SIMULATE FOR 2000 TRANSACTIONS
                END
```

```
                                                                CPU     0MIN 00.71SEC
-------------------------------------------------------------------------------
PROCESSOR TIME ---------0.00029 CPU HOURS @ $1,135.00 --------0.33
PROCESSOR STORAGE ------0.04102 K-BYTE HOURS @   $0.25 --------0.01
GPSS                                    TOTAL PROCESSOR COST -------$0.34
DISK EXCPS -----------------142 @  $0.36 PER 1000 -----------0.05
                I/O COST (EXCLUDING PRINTER/READER/PUNCH) -------$0.05

TOTAL COST -----------------------------------------------------$0.39
```

```
RELATIVE CLOCK          10008  ABSOLUTE CLOCK          10008
BLOCK COUNTS
BLOCK CURRENT    TOTAL     BLOCK CURRENT    TOTAL     BLOCK CURRENT    TOTAL     BLOCK CURRENT    TOTAL     BLOCK CURRENT    TOTAL
    1       0     2000        11       0      697
    2       0     2000        12       0      697
    3       0     2000        13       0      697
    4       0      816        14       0      487
    5       0      816        15       0      487
    6       0      816        16       0      487
    7       0      816        17       0      487
    8       0      816        18       0      487
    9       0      697
   10       0      697
```

FACILITIES

FACILITY	NUMBER ENTRIES	AVERAGE TIME/TRAN	-AVERAGE TOTAL TIME	UTILIZATION DURING- AVAIL. TIME	UNAVAIL. TIME	CURRENT STATUS	PERCENT AVAILABILITY	TRANSACTION NUMBER SEIZING	PREEMPTING
ABLE	816	9.805	.799				100.0		
BAKER	697	10.017	.697				100.0		
CHARL	487	10.398	.505				100.0		

QUEUES

QUEUE	MAXIMUM CONTENTS	AVERAGE CONTENTS	TOTAL ENTRIES	ZERO ENTRIES	PERCENT ZEROS	AVERAGE TIME/TRANS	$AVERAGE TIME/TRANS	TABLE NUMBER	CURRENT CONTENTS
LINE	5	.202	2000	1513	75.6	1.012	4.160		

$AVERAGE TIME/TRANS = AVERAGE TIME/TRANS EXCLUDING ZERO ENTRIES

END

***** TOTAL RUN TIME (INCLUDING ASSEMBLY) = .01 MINUTES *****

POLICE PHONE #41

A telephone in a police precinct is used for both emergency calls and personal calls. Personal calls are on a first come, first served basis, and are made at a rate of one every 5 + or - 1 minutes. Emergency calls have priority and can preempt other calls. They arrive at a rate of one every 15 + or - 5 minutes. Emergency calls take 3 + or - 1 minutes to complete while personal calls take 2 + or - 2 minutes. Twenty percent of the people using the phone on a nonemergency basis wish to make another call as soon as possible, but they are given the lowest priority for their second call. Simulate until 200 calls of all types have been completed. Estimate the phone utilization.

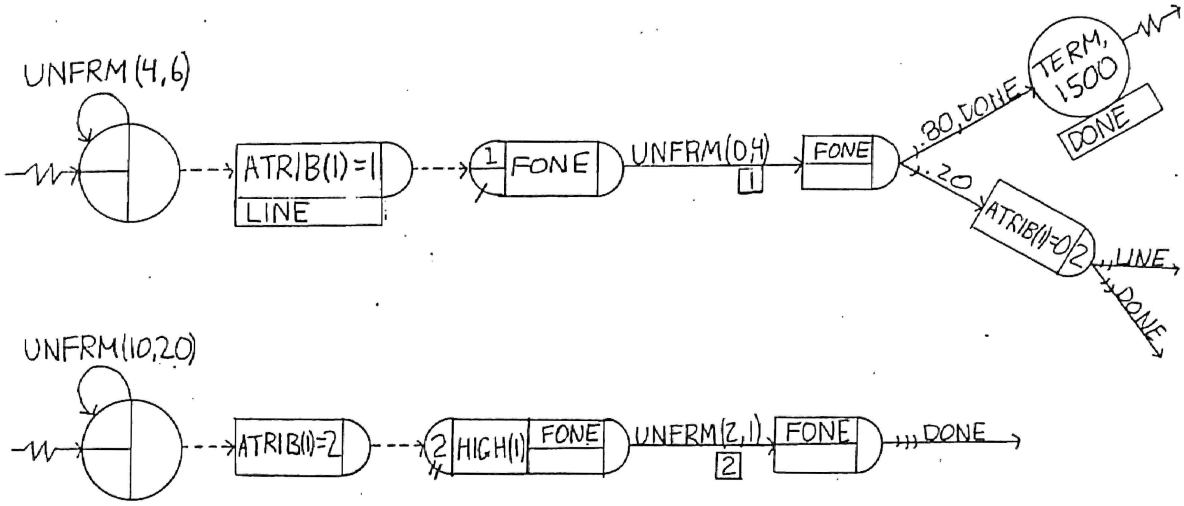
ANALYSIS OF SLAM AND GPSS RUNS

	SLAM	GPSS
Total System Run Time :	4773	4870
Avg. Phone Utilization:	.7021	.725
# of Emergency Calls :	321	322

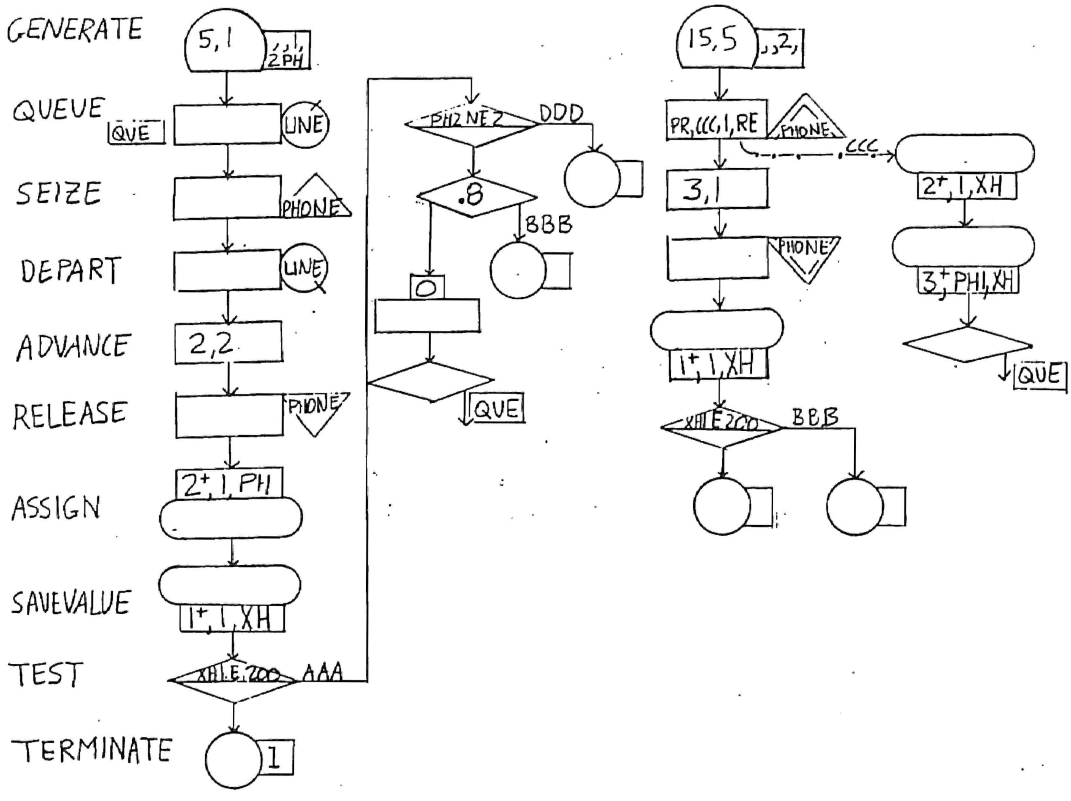
Once again, SLAM and GPSS give similar results.

SLAM NETWORK DIAGRAM

POLICE PHONE #41



GPSS NETWORK DIAGRAM



```
 1  GEN,BRADLEY,POLICE PHONE #41,6/2/85,1;
 2  LIMITS,2,1,500;
 3  PRIORITY/1,HVF(1);
 4  NETWORK;
 5        RESOURCE/FONE(1),2,1;
 6        CREATE,UNFRM(4,6);
 7        ASSIGN,ATRIB(1)=1;
 8  LINE  AWAIT(1),FONE;              WAIT
 9           ACT/1,UNFRM(0,4);        USE PHONE
10        FREE,FONE;                  HANG UP PHONE
11           ACT,,.8,DONE;            80% ARE DONE
12           ACT,,.2;                 20% MAKE ANOTHER CALL
13        GOON,1;
14        ASSIGN,ATRIB(1)=0.2;        REPEAT CALLERS ARE LOWEST PRIORITY
15           ACT,,,LINE;
16           ACT,,,DONE;
17  DONE  TERM,1500;
18  ;
19        CREATE,UNFRM(10,20);
20        ASSIGN,ATRIB(1)=2;
21        PREEMPT(2)/HIGH(1),FONE;
22           ACT/2,UNFRM(2,4);        MAKE PREEMPTING CALLS
23        FREE,FONE;
24           ACT,,,DONE;
25        ENDNETWORK;
26  FIN;
```

```
                                                                    CPU     0MIN 02.31SEC
-------------------------------------------------------------------------------------------
PROCESSOR TIME ---------0.00073 CPU HOURS @ $1,135.00 --------0.83
PROCESSOR STORAGE ------0.45173 K-BYTE HOURS @  $0.25 --------0.11
                                                TOTAL PROCESSOR COST -------$0.94
SLAM
DISK EXCPS -------------------51 @  $0.36 PER 1000 ------------0.02
                        I/O COST (EXCLUDING PRINTER/READER/PUNCH) -------$0.02

TOTAL COST (AFTER       $0.58   3RD SHIFT DISCOUNT) ---------$0.38
```

S L A M S U M M A R Y R E P O R T

SIMULATION PROJECT POLICE PHONE #41 BY BRADLEY

DATE 6/ 2/1985 RUN NUMBER 1 OF 1

CURRENT TIME 0.4773E+04
STATISTICAL ARRAYS CLEARED AT TIME 0.0000E+00

FILE STATISTICS

FILE NUMBER	ASSOCIATED NODE TYPE	AVERAGE LENGTH	STANDARD DEVIATION	MAXIMUM LENGTH	CURRENT LENGTH	AVERAGE WAITING TIME
1	AWAIT	0.2784	0.5168	3	0	1.1261
2	PREEMPT	0.0000	0.0000	1	0	0.0000
3	CALENDAR	2.7015	0.4598	5	3	1.6323

REGULAR ACTIVITY STATISTICS

ACTIVITY INDEX	AVERAGE UTILIZATION	STANDARD DEVIATION	MAXIMUM UTILIZATION	CURRENT UTILIZATION	ENTITY COUNT
1	0.5004	0.5000	1	1	1179
2	0.2017	0.4013	1	0	321

RESOURCE STATISTICS

RESOURCE NUMBER	RESOURCE LABEL	CURRENT CAPACITY	AVERAGE UTILIZATION	STANDARD DEVIATION	MAXIMUM UTILIZATION	CURRENT UTILIZATION
1	FONE	1	0.7021	0.4573	1	1

RESOURCE NUMBER	RESOURCE LABEL	CURRENT AVAILABLE	AVERAGE AVAILABLE	MINIMUM AVAILABLE	MAXIMUM AVAILABLE
1	FONE	0	0.2979	0	1

```
BLOCK
NUMBER   *LOC    OPERATION   A,B,C,D,E,F,G,H,I          COMMENTS
                 SIMULATE
         * POLICE PHONE #41
1                GENERATE    5,1,,,1,2PH       PERSONAL CALLS
2         QUE    QUEUE       LINE
3                SEIZE       PHONE
4                DEPART      LINE
5                ADVANCE     2,2
6                RELEASE     PHONE
7                ASSIGN      2+,1,PH
8                SAVEVALUE   1+,1,XH           COUNT TOTAL CALLS MADE
9                TEST E      XH1,1500,AAA      TEST IF 1500 CALLS MADE YET
10               TERMINATE   1
11        AAA    TEST NE     PH2,2,DDD
12               TRANSFER    .8,,BBB           80% ARE DONE AFTER ONE CALL
13               PRIORITY    0                 20% MAKE ANOTHER LOWEST PRIORITY CALL
14               TRANSFER    ,QUE
15               GENERATE    15,5,,,2          EMERGENCY CALLS
16               PREEMPT     PHONE,PR,CCC,1,RE
17               ADVANCE     3,1
18               RETURN      PHONE
19               SAVEVALUE   1+,1,XH           COUNT TOTAL CALLS MADE
20               TEST E      XH1,1500,BBB      TEST IF 1500 CALLS MADE YET
21               TERMINATE   1
22        BBB    TERMINATE
23        DDD    TERMINATE
24        CCC    SAVEVALUE   2+,1,XH           COUNT PREEMPTED CALLS
25               SAVEVALUE   3+,PH1,XH
26               TRANSFER    ,QUE
                 START       1
                 END
```

```
                                                                    CPU     0MIN 00.64SEC
-------------------------------------------------------------------------------------------
PROCESSOR TIME ---------0.00027 CPU HOURS @ $1,135.00 --------0.31
PROCESSOR STORAGE ------0.03698 K-BYTE HOURS @  $0.25 --------0.01
GPSS                                    TOTAL PROCESSOR COST -------$0.32
DISK EXCPS -----------------179 @  $0.36 PER 1000 ------------0.06
                  I/O COST (EXCLUDING PRINTER/READER/PUNCH) -------$0.06

TOTAL COST (AFTER       $0.23   3RD SHIFT DISCOUNT) ---------$0.15
```

```
RELATIVE CLOCK          4870  ABSOLUTE CLOCK          4870
BLOCK COUNTS
BLOCK CURRENT    TOTAL     BLOCK CURRENT    TOTAL     BLOCK CURRENT    TOTAL     BLOCK CURRENT    TOTAL     BLOCK CURRENT    TOTAL
    1       0      977        11       0     1177        21       0        0
    2       1     1353        12       0      975        22       0     1095
    3       0     1352        13       0      202        23       0      202
    4       0     1352        14       0      202        24       0      174
    5       0     1352        15       0      322        25       0      174
    6       0     1178        16       0      322        26       0      174
    7       0     1178        17       0      322
    8       0     1178        18       0      322
    9       0     1178        19       0      322
   10       0        1        20       0      322
```

FACILITIES

FACILITY	NUMBER ENTRIES	AVERAGE TIME/TRAN	-AVERAGE UTILIZATION DURING- TOTAL TIME	AVAIL. TIME	UNAVAIL. TIME	CURRENT STATUS	PERCENT AVAILABILITY	TRANSACTION NUMBER SEIZING	TRANSACTION NUMBER PREEMPTING
PHONE	1674	2.110	.725				100.0		

QUEUES

QUEUE	MAXIMUM CONTENTS	AVERAGE CONTENTS	TOTAL ENTRIES	ZERO ENTRIES	PERCENT ZEROS	AVERAGE TIME/TRANS	$AVERAGE TIME/TRANS	TABLE NUMBER	CURRENT CONTENTS
LINE	4	.440	1353	722	53.3	1.583	3.396		1

$AVERAGE TIME/TRANS = AVERAGE TIME/TRANS EXCLUDING ZERO ENTRIES

HALFWORD SAVEVALUES

NUMBER - CONTENTS	NUMBER - CONTENTS	NUMBER - CONTENTS	NUMBER - CONTENTS	NUMBER - CONTENTS	NUMBER - CONTENTS
1 1500	2 174	3 177			

END

***** TOTAL RUN TIME (INCLUDING ASSEMBLY) = .01 MINUTES *****

MESSAGE TRANSMISSION #44

Messages are generated at a rate of one every 35 + or - 10 seconds for transmission one at a time. Transmission takes 20 + or - 5 seconds. At intervals of 6 + or - 3 minutes, urgent messages lasting 10 + or - 3 seconds take over the transmission line. Any message in progress must be reprocessed for 2 minutes before it can be resubmitted for transmission. When resubmitted, it goes to the head of the line. Simulate for eight hours. Estimate the percentage of time the line is busy with ordinary messages.

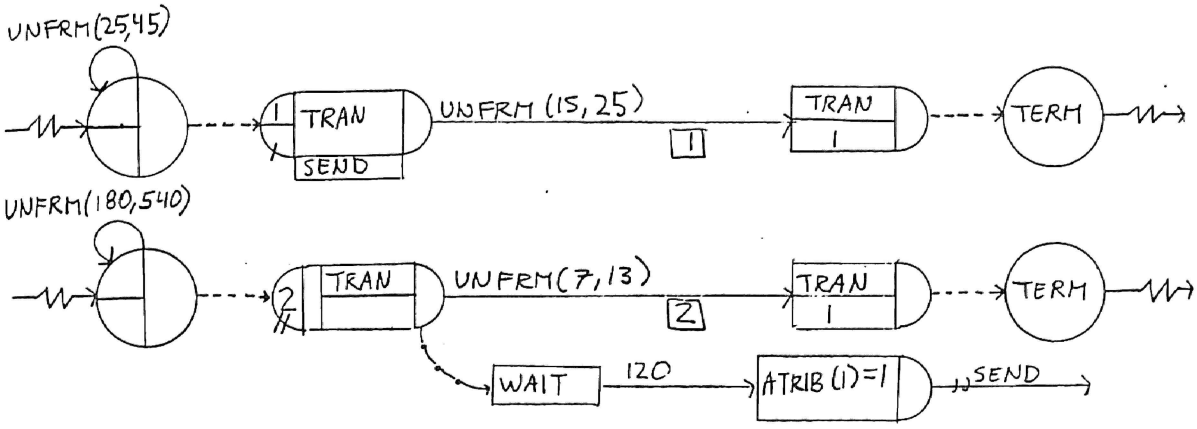
ANALYSIS OF SLAM AND GPSS RUNS

	SLAM	GPSS
%/time Ordinary Messages:	.5840	.583
Transmitter Utilization :	.6121	.609
Avg. Wait for Messages :	.9990	.831

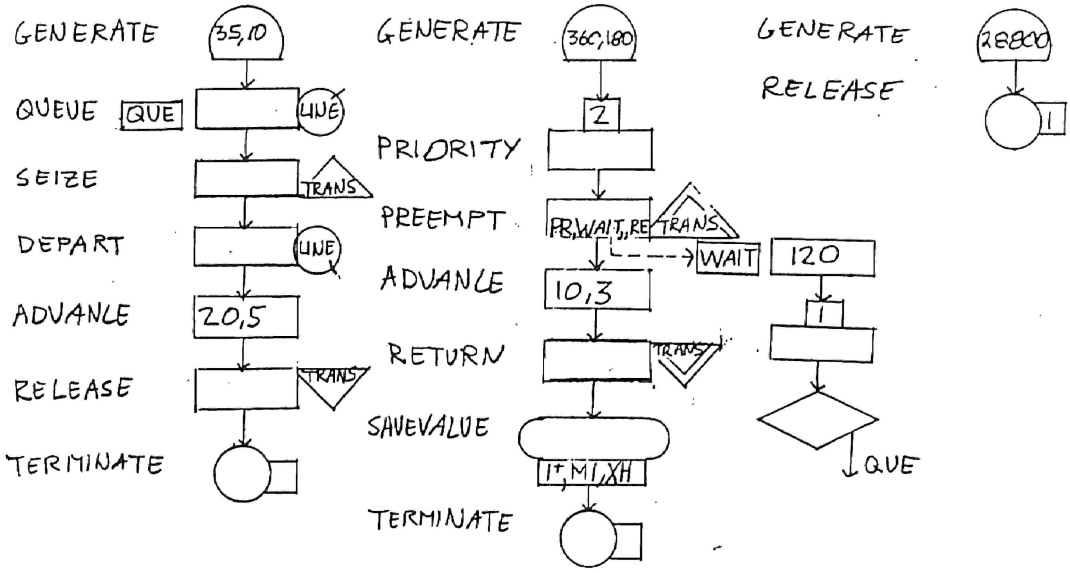
Once again, SLAM and GPSS have returned similar values.

SLAM NETWORK DIAGRAM

MESSAGE TRANSMISSION #44



GPSS NETWORK DIAGRAM



```
 1  GEN,BRADLEY,MESSAGE TRANSMISSION #44.5/30/85,1;
 2  LIMITS,2,1,500;
 3  PRIORITY/1,HVF(1);
 4  NETWORK;
 5        RESOURCE/TRAN(1),2,1;
 6        CREATE,UNFRM(25,45);          TRANSMISSION OF MESSAGES
 7  SEND  AWAIT(1),TRAN;
 8            ACT/1,UNFRM(15,25);
 9        FREE,TRAN;
10        TERM;
11  ;
12        CREATE,UNFRM(180,540);        URGENT MESSAGES
13        PREEMPT(2),TRAN,HOLD;         PREEMPT TRANSMITTER
14            ACT/2,UNFRM(7,13);
15        FREE,TRAN;
16        TERM;
17  ;
18  HOLD  GOON,1;
19            ACT,120;
20        ASSIGN,ATRIB(1)=1;
21            ACT,,,SEND;
22  ;
23        CREATE,,28800;             SIMULATE FOR 8 HOURS (IN SECS)
24        TERM,1;
25        ENDNETWORK;
26  FIN;
```

```
                                                    CPU     0MIN 01.49SEC
------------------------------------------------------------------------------
PROCESSOR TIME ---------0.00051 CPU HOURS @ $1,135.00 --------0.58
PROCESSOR STORAGE ------0.29138 K-BYTE HOURS @  $0.25 --------0.07
SLAM                                 TOTAL PROCESSOR COST -------$0.65

DISK EXCPS -------------------52 @  $0.36 PER 1000 ------------0.02
                I/O COST (EXCLUDING PRINTER/READER/PUNCH) -------$0.02

TOTAL COST (AFTER       $0.20   2ND SHIFT DISCOUNT) ---------$0.47
```

S L A M S U M M A R Y R E P O R T

SIMULATION PROJECT MESSAGE TRANSMISSION BY BRADLEY

DATE 5/30/1985 RUN NUMBER 1 OF 1

CURRENT TIME 0.2880E+05
STATISTICAL ARRAYS CLEARED AT TIME 0.0000E+00

FILE STATISTICS

FILE NUMBER	ASSOCIATED NODE TYPE	AVERAGE LENGTH	STANDARD DEVIATION	MAXIMUM LENGTH	CURRENT LENGTH	AVERAGE WAITING TIME
1	AWAIT	0.0301	0.1708	1	0	0.9990
2	PREEMPT	0.0000	0.0000	1	0	0.0000
3	CALENDAR	3.8031	0.6164	5	2	28.5453

REGULAR ACTIVITY STATISTICS

ACTIVITY INDEX	AVERAGE UTILIZATION	STANDARD DEVIATION	MAXIMUM UTILIZATION	CURRENT UTILIZATION	ENTITY COUNT
1	0.5840	0.4929	1	0	821
2	0.0280	0.1651	1	0	80

RESOURCE STATISTICS

RESOURCE NUMBER	RESOURCE LABEL	CURRENT CAPACITY	AVERAGE UTILIZATION	STANDARD DEVIATION	MAXIMUM UTILIZATION	CURRENT UTILIZATION
1	TRAN	1	0.6121	0.4873	1	0

RESOURCE NUMBER	RESOURCE LABEL	CURRENT AVAILABLE	AVERAGE AVAILABLE	MINIMUM AVAILABLE	MAXIMUM AVAILABLE
1	TRAN	1	0.3879	0	1

```
BLOCK
NUMBER   *LOC    OPERATION  A,B,C,D,E,F,G,H,I          COMMENTS
         * MESSAGE TRANSMISSION #44
                 SIMULATE
1                GENERATE   35,10          ONE MESSAGE EVERY 35 SEC +OR- 10 SEC
2          QUE   QUEUE      LINE
3                SEIZE      TRANS
4                DEPART     LINE
5                ADVANCE    20,5          TRANSMIT MESSAGE
6                RELEASE    TRANS
7                TERMINATE
         * GENERATE HIGH PRIORITY MESSAGES
8                GENERATE   360,180        URGENT MESSAGES
9                PRIORITY   2
10               PREEMPT    TRANS,PR,WAIT,,RE
11               ADVANCE    10,3          LENGTH OF URGENT MESSAGES
12               RETURN     TRANS
13               SAVEVALUE  1+,M1,XH      TOTAL TIME FOR URGENT MESSAGES
14               TERMINATE
15         WAIT  ADVANCE    120
16               PRIORITY   1
17               TRANSFER   ,QUE
18               GENERATE   28800         SIMULATE FOR 8 HOURS (IN SECS)
19               TERMINATE  1
                 START      1
                 END
```

```
                                                                    CPU     0MIN 00.41SEC
-------------------------------------------------------------------------------------------
PROCESSOR TIME ---------0.00021 CPU HOURS @ $1,135.00 --------0.24
PROCESSOR STORAGE ------0.02369 K-BYTE HOURS @  $0.25 --------0.01
GPSS                             TOTAL PROCESSOR COST -------$0.25
DISK EXCPS ------------------155 @  $0.36 PER 1000 ------------0.05
                I/O COST (EXCLUDING PRINTER/READER/PUNCH) -------$0.05

TOTAL COST (AFTER       $0.09   2ND SHIFT DISCOUNT) ---------$0.21
```

```
RELATIVE CLOCK        28800  ABSOLUTE CLOCK        28800
BLOCK COUNTS
BLOCK CURRENT    TOTAL     BLOCK CURRENT    TOTAL     BLOCK CURRENT    TOTAL     BLOCK CURRENT    TOTAL     BLOCK CURRENT    TOTAL
    1       0      826        11       0       76
    2       0      866        12       0       76
    3       0      866        13       0       76
    4       0      866        14       0       76
    5       1      866        15       1       41
    6       0      824        16       0       40
    7       0      824        17       0       40
    8       0       76        18       0        1
    9       0       76        19       0        1
   10       0       76
```

****
*
* FACILITIES
*
****

FACILITY	NUMBER ENTRIES	AVERAGE TIME/TRAN	-AVERAGE UTILIZATION DURING- TOTAL TIME	AVAIL. TIME	UNAVAIL. TIME	CURRENT STATUS	PERCENT AVAILABILITY	TRANSACTION NUMBER SEIZING	PREEMPTING
TRANS	942	18.648	.609				100.0	1	

****
*
* QUEUES
*
****

QUEUE	MAXIMUM CONTENTS	AVERAGE CONTENTS	TOTAL ENTRIES	ZERO ENTRIES	PERCENT ZEROS	AVERAGE TIME/TRANS	$AVERAGE TIME/TRANS	TABLE NUMBER	CURRENT CONTENTS
LINE	1	.024	866	777	89.7	.831	8.089		

$AVERAGE TIME/TRANS = AVERAGE TIME/TRANS EXCLUDING ZERO ENTRIES

****
*
* HALFWORD SAVEVALUES
*
****

NUMBER	CONTENTS	NUMBER	CONTENTS	NUMBER	CONTENTS	NUMBER	CONTENTS	NUMBER	CONTENTS	NUMBER	CONTENTS
1	751										

END

***** TOTAL RUN TIME (INCLUDING ASSEMBLY) = .00 MINUTES *****

DEPARTMENT STORE #50

Shopping times at a department store have been found to have the following distribution:

Shopping Time (Minutes)	Number of Shoppers
0-10	90
10-30	120
20-30	270
30-40	145
40-50	88
50-60	28

After shopping, the customers choose one of six checkout counters. Checkout times are normally distributed with a mean of 5.1 minutes and a standard deviation of 0.7 minute. Interarrival times are exponentially distributed with a mean of 1 minute. Gather statistics for each checkout counter (including queues). Tabulate the distribution of time to complete shopping, and the distribution of time to complete shopping and checkout procedures. What proportion of customers spend more that 40 minutes in the store? Simulate for one 16-hour day.

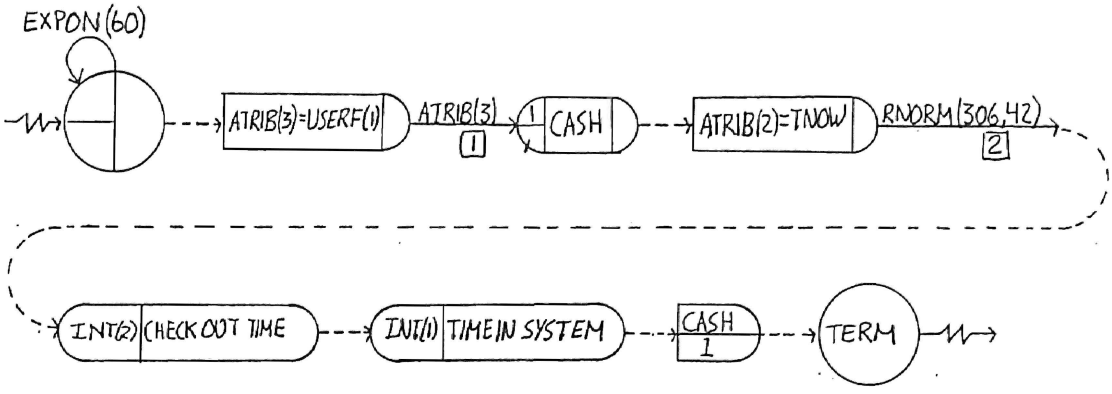
ANALYSIS OF SLAM AND GPSS RUNS

	SLAM	GPSS
Avg. Checker Utilization:	.8470	.849
Avg. Checkout Time :	304.8	303.505
Number Checked Out :	958	967
% Taking Over 40 Min. :	34.2%	18.7%
Avg. Wait for a Checker :	179.6648 secs	97.671 secs
Avg. Time in Store :	2101 secs	1731.276 secs

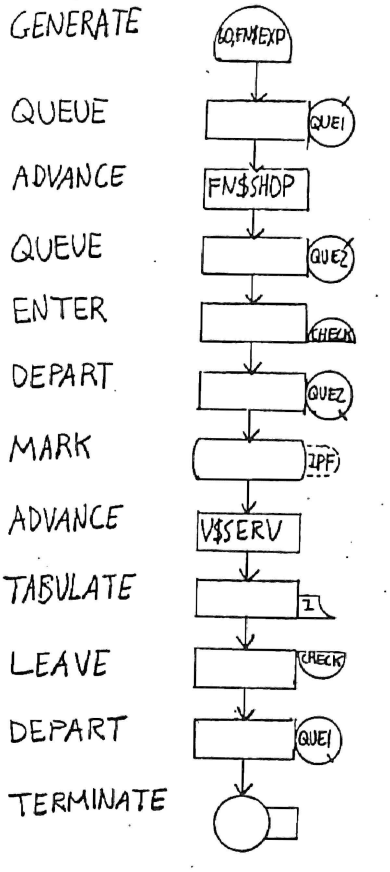
The average customer spent 2101 seconds, or 35.0 minutes, in the store in the SLAM simulation, compared to 1731.276 seconds, or 28.9 minutes, in the GPSS simulation. The difference is only 6.1 minutes, and is probably due to differences in the way the SLAM and GPSS table look up functions work. Other that that, all the statistics are in reasonable proximity to each other. Note the output tables that have been produced. A copy of the SLAM Echo Report has also been included.

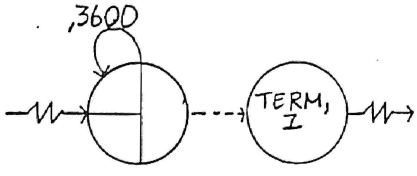
SLAM NETWORK DIAGRAM

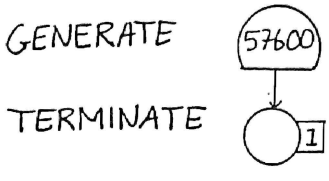
DEPARTMENT STORE #50



GPSS NETWORK DIAGRAM







```
     *....*...1.........2.........3.........4.........5.........6.........7.*

 1          DIMENSION NSET(5000)
 2          COMMON QSET(5000)
 3          COMMON/SCOM1/ ATRIB(100),DD(100),DDL(100),DTNOW,II,MFA,MSTOP,NCLNR
           1,NCRDR,NPRNT,NNRUN,NNSET,NTAPE,SS(100),SSL(100),TNEXT,TNOW,XX(100)
 4          EQUIVALENCE (NSET(1),QSET(1))
 5          NCRDR=5
 6          NPRNT=6
 7          NTAPE=7
 8          NNSET=5000
 9          CALL SLAM
10          STOP
11          END
```

```
 1          FUNCTION USERF(IFN)
 2          DIMENSION XVAL(6),FX(6)
 3          DATA XVAL/300.,900.,1500.,2100.,2700.,3300./
 4          DATA FX/.121,.283,.647,.843,.962,1./
 5          GO TO (1),IFN
 6        1 USERF=DPROB(FX,XVAL,6,1)
 7          RETURN
 8          END
```

```
 1  GEN,BRADLEY,DEPARTMENT STORE #50,6/7/85,1;
 2  LIMITS,1,3,250;
 3  NETWORK;
 4        RESOURCE/CASH(6),1;
 5        CREATE,EXPON(60),,1;
 6        ASSIGN,ATRIB(3)=USERF(1);
 7            ACT/1,ATRIB(3);          SHOP IN STORE
 8        AWAIT(1),CASH/1;
 9        ASSIGN,ATRIB(2)=TNOW;
10            ACT/2,RNORM(306,42);     BUY GOODS
11        COLCT,INT(2),CHECK OUT TIME,13,150,20;
12        COLCT,INT(1),TIME IN SYSTEM,18,200,200;
13        FREE,CASH/1;
14        TERM;
15  ;
16        CREATE,,57600;               SIMULATE FOR ONE 16 HOUR DAY
17        TERM,1;
18        ENDNETWORK;
19  FIN;
```

```
U15799AA FORT - STEP WAS EXECUTED - COND CODE 0000
STEP /FORT    / START 85167.1831
STEP /FORT    / STOP  85167.1831 CPU     0MIN 00.11SEC
U15799AA LKED - STEP WAS EXECUTED - COND CODE 0000
STEP /LKED    / START 85167.1831
STEP /LKED    / STOP  85167.1832 CPU     0MIN 03.31SEC
U15799AA SLAM - STEP WAS EXECUTED - COND CODE 0000
STEP /SLAM    / START 85167.1832
STEP /SLAM    / STOP  85167.1832 CPU     0MIN 02.06SEC
 JOB /U15799AA/ START 85167.1831
 JOB /U15799AA/ STOP  85167.1832 CPU     0MIN 05.48SEC
-------------------------------------------------------------------------
PROCESSOR TIME ---------0.00180 CPU HOURS @ $1,135.00 --------2.04
PROCESSOR STORAGE ------0.67050 K-BYTE HOURS @  $0.25 --------0.17
SLAM                                TOTAL PROCESSOR COST -------$2.21
DISK EXCPS ---------------3,262 @  $0.36 PER 1000 ------------1.17
                I/O COST (EXCLUDING PRINTER/READER/PUNCH) -------$1.17

TOTAL COST (AFTER       $2.03   3RD SHIFT DISCOUNT) ---------$1.35
```

S L A M E C H O R E P O R T

SIMULATION PROJECT DEPARTMENT STORE #50 BY BRADLEY

DATE 6/ 2/1985 RUN NUMBER 1 OF 1

SLAM VERSION FEB 84

GENERAL OPTIONS

PRINT INPUT STATEMENTS (ILIST):	YES
PRINT ECHO REPORT (IECHO):	YES
EXECUTE SIMULATIONS (IXQT):	YES
PRINT INTERMEDIATE RESULTS HEADING (IPIRH):	YES
PRINT SUMMARY REPORT (ISMRY):	YES

LIMITS ON FILES

MAXIMUM NUMBER OF USER FILES (MFILS):	1
MAXIMUM NUMBER OF USER ATTRIBUTES (MATR):	3
MAXIMUM NUMBER OF CONCURRENT ENTRIES (MNTRY):	500

FILE SUMMARY

FILE NUMBER	INITIAL ENTRIES	RANKING CRITERION
1	0	FIFO

STATISTICS BASED ON OBSERVATIONS

COLCT NUMBER	COLLECTION MODE	IDENTIFIER	HISTOGRAM SPECIFICATIONS NCEL	HLOW	HWID
1	NETWORK	TIME IN SYSTEM	19	0.200E+03	0.200E+03
2	NETWORK	CHECK OUT TIME	19	0.200E+02	0.100E+02

RANDOM NUMBER STREAMS

STREAM NUMBER	SEED VALUE	REINITIALIZATION OF STREAM
1	428956419	NO
2	1954324947	NO
3	1145661099	NO
4	1835732737	NO
5	794161987	NO
6	1329531353	NO
7	200496737	NO
8	633816299	NO
9	1410143363	NO
10	1282538739	NO

INITIALIZATION OPTIONS

BEGINNING TIME OF SIMULATION (TTBEG):	0.0000E+00
ENDING TIME OF SIMULATION (TTFIN):	0.1000E+21
STATISTICAL ARRAYS CLEARED (JJCLR):	YES
VARIABLES INITIALIZED (JJVAR):	YES
FILES INITIALIZED (JJFIL):	YES

NSET/QSET STORAGE ALLOCATION

DIMENSION OF NSET/QSET (NNSET):	5000
WORDS ALLOCATED TO FILING SYSTEM:	3500
WORDS ALLOCATED TO INDEXED LIST TAGS:	390
WORDS ALLOCATED TO NETWORK:	122
WORDS AVAILABLE FOR PLOTS/TABLES:	988

INPUT ERRORS DETECTED: 0

EXECUTION WILL BE ATTEMPTED

S L A M S U M M A R Y R E P O R T

SIMULATION PROJECT DEPARTMENT STORE #50 BY BRADLEY

DATE 6/ 7/1985 RUN NUMBER 1 OF 1

CURRENT TIME 0.5760E+05
STATISTICAL ARRAYS CLEARED AT TIME 0.0000E+00

STATISTICS FOR VARIABLES BASED ON OBSERVATION

	MEAN VALUE	STANDARD DEVIATION	COEFF. OF VARIATION	MINIMUM VALUE	MAXIMUM VALUE	NUMBER OF OBSERVATIONS
CHECK OUT TIME	0.3048E+03	0.4364E+02	0.1432E+00	0.1381E+03	0.4380E+03	958
TIME IN SYSTEM	0.2101E+04	0.7892E+03	0.3757E+00	0.5177E+03	0.4504E+04	958

FILE STATISTICS

FILE NUMBER	ASSOCIATED NODE TYPE	AVERAGE LENGTH	STANDARD DEVIATION	MAXIMUM LENGTH	CURRENT LENGTH	AVERAGE WAITING TIME
1	AWAIT	3.0007	3.9071	18	0	179.6648
2	CALENDAR	34.6716	7.4005	54	41	409.2385

REGULAR ACTIVITY STATISTICS

ACTIVITY INDEX	AVERAGE UTILIZATION	STANDARD DEVIATION	MAXIMUM UTILIZATION	CURRENT UTILIZATION	ENTITY COUNT
1	27.5955	6.8972	47	36	962
2	5.0818	1.5140	6	4	958

RESOURCE STATISTICS

RESOURCE NUMBER	RESOURCE LABEL	CURRENT CAPACITY	AVERAGE UTILIZATION	STANDARD DEVIATION	MAXIMUM UTILIZATION	CURRENT UTILIZATION
1	CASH	6	5.0818	1.5140	6	4

RESOURCE NUMBER	RESOURCE LABEL	CURRENT AVAILABLE	AVERAGE AVAILABLE	MINIMUM AVAILABLE	MAXIMUM AVAILABLE
1	CASH	2	0.9177	0	6

HISTOGRAM NUMBER 1

CHECK OUT TIME

OBSV FREQ	RELA FREQ	CUML FREQ	UPPER CELL LIMIT	0 20 40 60 80 100
				+ + + + + + + + + + +
1	0.001	0.001	0.1500E+03	+
0	0.000	0.001	0.1700E+03	+
3	0.003	0.004	0.1900E+03	+
8	0.008	0.013	0.2100E+03	+C
32	0.033	0.046	0.2300E+03	+**
53	0.055	0.101	0.2500E+03	+*** C
120	0.125	0.227	0.2700E+03	+****** C
141	0.147	0.374	0.2900E+03	+******** C
153	0.160	0.533	0.3100E+03	+********* C
177	0.185	0.718	0.3300E+03	+********** C
126	0.132	0.850	0.3500E+03	+******** C
71	0.074	0.924	0.3700E+03	+**** C
51	0.053	0.977	0.3900E+03	+*** C
15	0.016	0.993	0.4100E+03	+* C
7	0.007	1.000	INF	+ C
---				+ + + + + + + + + + +
958				0 20 40 60 80 100

STATISTICS FOR VARIABLES BASED ON OBSERVATION

	MEAN VALUE	STANDARD DEVIATION	COEFF. OF VARIATION	MINIMUM VALUE	MAXIMUM VALUE	NUMBER OF OBSERVATIONS
CHECK OUT TIME	0.3048E+03	0.4364E+02	0.1432E+00	0.1381E+03	0.4380E+03	958

HISTOGRAM NUMBER 2

TIME IN SYSTEM

OBSV FREQ	RELA FREQ	CUML FREQ	UPPER CELL LIMIT	0 20 40 60 80 100
				+ + + + + + + + + + +
0	0.000	0.000	0.2000E+03	+
0	0.000	0.000	0.4000E+03	+
18	0.019	0.019	0.6000E+03	+*
46	0.048	0.067	0.8000E+03	+**C
14	0.015	0.081	0.1000E+04	+* C
38	0.040	0.121	0.1200E+04	+** C
77	0.080	0.201	0.1400E+04	+**** C
40	0.042	0.243	0.1600E+04	+** C
80	0.084	0.327	0.1800E+04	+**** C
181	0.189	0.516	0.2000E+04	+********* C
60	0.063	0.578	0.2200E+04	+*** C
76	0.079	0.658	0.2400E+04	+**** C
92	0.096	0.754	0.2600E+04	+***** C
39	0.041	0.794	0.2800E+04	+** C
50	0.052	0.847	0.3000E+04	+*** C
60	0.063	0.909	0.3200E+04	+*** C
25	0.026	0.935	0.3400E+04	+** C
27	0.028	0.963	0.3600E+04	+* C
18	0.019	0.982	0.3800E+04	+* C
17	0.018	1.000	INF	+* C
---				+ + + + + + + + + + +
958				0 20 40 60 80 100

STATISTICS FOR VARIABLES BASED ON OBSERVATION

	MEAN VALUE	STANDARD DEVIATION	COEFF. OF VARIATION	MINIMUM VALUE	MAXIMUM VALUE	NUMBER OF OBSERVATIONS
TIME IN SYSTEM	0.2101E+04	0.7892E+03	0.3757E+00	0.5177E+03	0.4504E+04	958

```
BLOCK
NUMBER   *LOC    OPERATION  A,B,C,D,E,F,G,H,I          COMMENTS
                SIMULATE
                *
                 CHECK STORAGE    6
                *
                 NORM   FUNCTION   RN1,C25     NORMAL GENERATOR
                0,-5/.00003,-4/.00135,-3/.00621,-2.5/.02275,-2/.06681,-1.5
                .11507,-1.2/.15866,-1/.21186,-.8/.27425,-.6/.34458,-.4/.42074,-.2
                .5,0/.57926,.2/.65542,.4/.72575,.6/.78814,.8/.84134,1/.88493,1.2
                .93319,1.5/.97725,2/.99379,2.5/.99865,3/.99997,4/1,5
                *
                 EXP    FUNCTION   RN1,C24     EXPONENTIAL GENERATOR
                0,0/.1,.104/.2,.222/.3,.355/.4,.509/.5,.69
                .6,.915/.7,1.2/.75,1.38/.8,1.6/.84,1.83/.88,2.12
                .9,2.3/.92,2.52/.94,2.81/.95,2.99/.96,3.2/.97,3.5
                .98,3.9/.99,4.6/.995,5.3/.998,6.2/.999,7/.9997,8
                *
                 SHOP   FUNCTION   RN1,C6
                .121,300/.283,900/.647,1500/.843,2100
                .962,2700/1.0,3300
                *
                 SERV   FVARIABLE  306+42*FN$NORM
                *
                * DEPARTMENT STORE #50
                *
1                       GENERATE    60,FN$EXP,,,,1PF
2                       QUEUE       QUE1          ENTER STORE
3                       ADVANCE     FN$SHOP       SHOP IN STORE
4                       QUEUE       QUE2
5                       ENTER       CHECK
6                       DEPART      QUE2
7                       MARK        1PF
8                       ADVANCE     V$SERV        PAY CASHIER
9                       TABULATE    1
10                      LEAVE       CHECK         LEAVE STORE
11                      DEPART      QUE1
12                      TERMINATE
                *
13                      GENERATE    57600         SIMULATE FOR ONE 16 HOUR DAY
14                      TERMINATE   1
                *
                 1      TABLE       MP1PF,150,20,15      CHECK OUT TIME
                 2      QTABLE      QUE1,200,200,20      TIME IN SYSTEM
                *
                        START       1
                        END
```

```
                                                                CPU     0MIN 00.79SEC
-------------------------------------------------------------------------------------
PROCESSOR TIME ---------0.00031 CPU HOURS @ $1,135.00 --------0.35
PROCESSOR STORAGE ------0.04564 K-BYTE HOURS @  $0.25 --------0.01
GPSS                                    TOTAL PROCESSOR COST -------$0.36
DISK EXCPS -----------------254 @  $0.36 PER 1000 -----------0.09
                    I/O COST (EXCLUDING PRINTER/READER/PUNCH) -------$0.09

TOTAL COST (AFTER       $0.27   3RD SHIFT DISCOUNT) ---------$0.18
```

```
RELATIVE CLOCK        57600  ABSOLUTE CLOCK        57600
BLOCK COUNTS
BLOCK CURRENT    TOTAL    BLOCK CURRENT    TOTAL    BLOCK CURRENT    TOTAL    BLOCK CURRENT    TOTAL    BLOCK CURRENT    TOTAL
    1       0      994       11       0      963
    2       0      994       12       0      963
    3      27      994       13       0        1
    4       0      967       14       0        1
    5       0      967
    6       0      967
    7       0      967
    8       4      967
    9       0      963
   10       0      963
```

STORAGES

STORAGE	CAPACITY	AVERAGE CONTENTS	ENTRIES	AVERAGE TIME/UNIT	-AVERAGE UTILIZATION DURING- TOTAL TIME	AVAIL. TIME	UNAVAIL. TIME	CURRENT STATUS	PERCENT AVAILABILITY	CURRENT CONTENTS	MAXIMUM CONTENTS
CHECK	6	5.095	967	303.505	.849				100.0	4	6

QUEUES

QUEUE	MAXIMUM CONTENTS	AVERAGE CONTENTS	TOTAL ENTRIES	ZERO ENTRIES	PERCENT ZEROS	AVERAGE TIME/TRANS	$AVERAGE TIME/TRANS	TABLE NUMBER	CURRENT CONTENTS
QUE1	44	29.340	994		.0	1700.220	1700.220	2	31
QUE2	11	1.639	967	333	34.4	97.671	148.971		

$AVERAGE TIME/TRANS = AVERAGE TIME/TRANS EXCLUDING ZERO ENTRIES

```
**************************************
*                                    *
*              TABLES                *
*                                    *
**************************************
```

TABLE 1

ENTRIES IN TABLE	MEAN ARGUMENT	STANDARD DEVIATION	SUM OF ARGUMENTS	
963	304.252	41.750	292995.000	NON-WEIGHTED

UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE	CUMULATIVE REMAINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN
150	0	.00	.0	100.0	.493	-3.694
170	1	.10	.1	99.8	.558	-3.215
190	5	.51	.6	99.3	.624	-2.736
210	6	.62	1.2	98.7	.690	-2.257
230	30	3.11	4.3	95.6	.755	-1.778
250	54	5.60	9.9	90.0	.821	-1.299
270	94	9.76	19.7	80.2	.887	-.820
290	166	17.23	36.9	63.0	.953	-.341
310	189	19.62	56.5	43.4	1.018	.137
330	156	16.19	72.7	27.2	1.084	.616
350	137	14.22	87.0	12.9	1.150	1.095
370	66	6.85	93.8	6.1	1.216	1.574
390	46	4.77	98.6	1.3	1.281	2.053
410	9	.93	99.5	.4	1.347	2.532
OVERFLOW	4	.41	100.0	.0		

AVERAGE VALUE OF OVERFLOW 418.50

TABLE 2

ENTRIES IN TABLE	MEAN ARGUMENT	STANDARD DEVIATION	SUM OF ARGUMENTS	
963	1731.276	741.000	1667219.000	NON-WEIGHTED

UPPER LIMIT	OBSERVED FREQUENCY	PER CENT OF TOTAL	CUMULATIVE PERCENTAGE	CUMULATIVE REMAINDER	MULTIPLE OF MEAN	DEVIATION FROM MEAN
200	0	.00	.0	100.0	.115	-2.066
400	0	.00	.0	100.0	.231	-1.796
600	20	2.07	2.0	97.9	.346	-1.526
800	106	11.00	13.0	86.9	.462	-1.256
1000	64	6.64	19.7	80.2	.577	-.986
1200	51	5.29	25.0	74.9	.693	-.716
1400	94	9.76	34.7	65.2	.808	-.447
1600	107	11.11	45.8	54.1	.924	-.177
1800	129	13.39	59.2	40.7	1.039	.092
2000	68	7.06	66.3	33.6	1.155	.362
2200	71	7.37	73.7	26.2	1.270	.632
2400	72	7.47	81.2	18.7	1.386	.902
2600	41	4.25	85.4	14.5	1.501	1.172
2800	47	4.88	90.3	9.6	1.617	1.442
3000	37	3.84	94.1	5.8	1.732	1.712
3200	23	2.38	96.5	3.4	1.848	1.982
3400	13	1.34	97.9	2.0	1.963	2.251
3600	11	1.14	99.0	.9	2.079	2.521
3800	8	.83	99.8	.1	2.194	2.791
OVERFLOW	1	.10	100.0	.0		

AVERAGE VALUE OF OVERFLOW 3859.00

END

***** TOTAL RUN TIME (INCLUDING ASSEMBLY) = .01 MINUTES *****

PHEASANT FARM

Pheasant chicks are purchased in lots of 3000 on the 1st, 5th, 9th and 13th weeks. Chicks of a given age wait two weeks in pens 1, 2 and 3, 14 weeks in pen four, and then go to pen 5 to be sold in batches of 400. The last batch sold, however, may include all pheasants left over, so it will total 400 to 800 pheasants and will clear out the farm. The first pen has a 12% attrition rate, the second pen a 9% rate, the third a 6% rate, and the fourth a 5% rate. Each pen requires a different amount of food. The pheasant farmer wants to know how many pheasants will be in each pen for a given week, so that he will know how much feed to buy. Produce an output report showing the amount of pheasants in each pen by, week, and the number of pheasants ready to sell, by week.

ANALYSIS OF SLAM AND GPSS RUNS

A comparison of the SLAM REGULAR ACTIVITY STATISTICS with the GPSS QUEUES output shows very little difference. The SLAM program took 5.76 seconds to execute, compared to .86 seconds for the GPSS program. That amounted to first shift costs of $3.53 versus $0.60. This was due to the need to write a Fortran output subroutine for the SLAM program in order to label and explain the results.

```
**** TSO FOREGROUND HARDCOPY ****
DSNAME=U15799A.FARM.DATA

//U15799AD  JOB (15799,SSS-SS-SSSS),'BRADLEY',CLASS=A,                    00000010
//  TIME=(0,10),MSGCLASS=X,NOTIFY=U15799A                                  00000020
/*PASSWORD ?                                                              00000030
/*JOBPARM FORMS=9001,ROOM=R,COPIES=1                                      00000040
//  EXEC SLAMCLG                                                          00000050
//FORT.SYSIN DD *                                                         00000060
      DIMENSION NSET(5000)                                              00000070
      COMMON QSET(5000)                                                 00000080
      COMMON/SCOM1/ ATRIB(100),DD(100),DDL(100),DTNOW,II,MFA,MSTOP,NCLNR00000090
     1,NCRDR,NPRNT,NNRUN,NNSET,NTAPE,SS(100),SSL(100),TNEXT,TNOW,XX(100)00000100
      COMMON NNACT(100)                                                 00000110
      EQUIVALENCE (NSET(1),QSET(1))                                     00000120
      NCRDR=5                                                           00000130
      NPRNT=6                                                           00000140
      NTAPE=7                                                           00000150
      NNSET=5000                                                        00000160
      CALL SLAM                                                         00000170
      STOP                                                              00000180
      END                                                               00000190
      FUNCTION USERF(IFN)                                               00000200
      COMMON/SCOM1/ ATRIB(100),DD(100),DDL(100),DTNOW,II,MFA,MSTOP,NCLNR00000210
     1,NCRDR,NPRNT,NNRUN,NNSET,NTAPE,SS(100),SSL(100),TNEXT,TNOW,XX(100)00000220
      COMMON NNACT(100)                                                 00000230
      USERF=1.0                                                         00000240
      CALL PRINT                                                        00000250
      RETURN                                                            00000260
      END                                                               00000270
      SUBROUTINE PRINT                                                  00000280
      COMMON/SCOM1/ ATRIB(100),DD(100),DDL(100),DTNOW,II,MFA,MSTOP,NCLNR00000290
     1,NCRDR,NPRNT,NNRUN,NNSET,NTAPE,SS(100),SSL(100),TNEXT,TNOW,XX(100)00000300
      COMMON NNACT(100)                                                 00000310
      WRITE(6,5)                                                        00000320
    5 FORMAT ('0 ')                                                     00000330
C*****THIS SUBROUTINE PRODUCES AN OUTPUT REPORT                         00000340
      DO 20 J=1,4                                                       00000350
      WRITE(6,10)J,SS(J)*20.0,J,XX(J)*20.0                              00000360
   10 FORMAT ('0     PHEASANTS IN PEN ',I1,':  ',F6.0,                  00000370
     1'     BIRDS DYING IN PEN ',I1,':  ',F6.0)                        00000380
   20 CONTINUE                                                          00000390
      WRITE(6,30)XX(5)*20.0,XX(6)*20.0                                  00000400
   30 FORMAT ('      PHEASANTS READY TO BE SOLD:  ',F6.0,               00000410
     1'     PHEASANTS SOLD THIS WEEK    ',F6.0)                        00000420
      WRITE(6,40)TNOW                                                   00000430
   40 FORMAT ('      THE PREVIOUS REPORT WAS FOR WEEK ',F4.0)           00000440
      RETURN                                                            00000450
      END                                                               00000460
/*                                                                      00000470
//SLAM.SYSIN DD *                                                       00000480
GEN,BRADLEY,PHEASANT FARM,6/10/85,1;                                    00000490
LIMITS,0,0,500;                                                         00000500
NETWORK;                                                                00000510
      CREATE,0,0,,150;              GENERATE 150 CREATIONS (BUNDLES)    00000520
BUY   GOON,1;                       A BUNDLE REPRESENTS 20 PHEASANTS    00000530
          ACT,,.12,DIE1;            12% IN FIRST PEN DIE                00000540
          ACT/1,2,.88;              TWO WEEKS IN FIRST PEN              00000550
      GOON,1;                                                           00000560
          ACT,,.09,DIE2;            9% IN SECOND PEN DIE                00000570
          ACT/2,2,.91;                                                  00000580
      GOON,1;                                                           00000590
```

```
          ACT,,.06,DIE3;            6% IN THIRD PEN DIE                  00000600
          ACT/3,2,.94;                                                   00000610
       GOON,1;                                                           00000620
          ACT,,.05.DIE4;            5% IN FOURTH PEN DIE                 00000630
          ACT/4,14,.95;             14 WEEKS ARE SPENT IN FOURTH PEN     00000640
       ASSIGN,XX(5)=XX(5)+1.0;      XX(5) IS SURVIVING BIRDS             00000650
       TERM;                        BIRDS ARE SOLD AND EXIT SYSTEM       00000660
DIE1   ASSIGN,XX(1)=XX(1)+1.0;      XX(1) IS # THAT DIE IN PEN 1         00000670
       TERM;                                                             00000680
DIE2   ASSIGN,XX(2)=XX(2)+1.0;                                           00000690
       TERM;                                                             00000700
DIE3   ASSIGN,XX(3)=XX(3)+1.0;                                           00000710
       TERM;                                                             00000720
DIE4   ASSIGN,XX(4)=XX(4)+1.0;                                           00000730
       TERM;                                                             00000740
;                                                                        00000750
       CREATE,0,5,,150;             GENERATE 150 BUNDLES IN 5 WEEKS     00000760
          ACT,,,BUY;                                                     00000770
       CREATE,0,9,,150;             GENERATE 150 BUNDLES IN 9 WEEKS     00000780
          ACT,,,BUY;                                                     00000790
       CREATE,0,13,,150;            GENERATE 150 BUNDLES IN 13 WEEKS    00000800
          ACT,,,BUY;                                                     00000810
;                                                                        00000820
       CREATE,1,,,,1;                                                    00000830
          ACT,,TNOW.LT.33.0,AAA;    GO TO AAA IF TNOW (WEEKS) LT 33      00000840
          ACT,,XX(5).GE.40.0,AAB;   GO TO AAB IF BIRDS TO SELL GE 40     00000850
          ACT;                                                           00000860
       ASSIGN,XX(6)=XX(6)+XX(5);    ADD BIRDS LEFT XX(5) TO SOLD XX(6)   00000870
       ASSIGN,XX(5)=XX(5)-XX(5);    BIRDS JUST SOLD LESS BIRDS LEFT      00000880
       ASSIGN,SS(1)=NNACT(1),SS(2)=NNACT(2);     COUNT # IN ACTIVITY    00000890
       ASSIGN,SS(3)=NNACT(3),SS(4)=NNACT(4);                             00000900
       ASSIGN,XX(7)=USERF(1);                                            00000910
       TERM,1;                                                           00000920
AAA    GOON,1;                                                           00000930
          ACT,,XX(5).LT.20.0,AAC;   IF SELLABLE BIRDS LT 20, GO TO AAC   00000940
          ACT;                                                           00000950
AAB    ASSIGN,XX(6)=XX(6)+20.0;     ADD 20 TO BIRDS SOLD XX(6)           00000960
       ASSIGN,XX(5)=XX(5)-20.0;     SUBTRACT 20 FROM BIRDS LEFT XX(5)    00000970
AAC    ASSIGN,SS(1)=NNACT(1),SS(2)=NNACT(2);                             00000980
       ASSIGN,SS(3)=NNACT(3),SS(4)=NNACT(4);                             00000990
       ASSIGN,XX(7)=USERF(1);                                            00001000
       ASSIGN,XX(6)=0.0;            CLEAR BIRDS SOLD COUNTER             00001010
       TERM;                                                             00001020
       ENDNETWORK;                                                       00001030
FIN;                                                                     00001040
/*                                                                       00001050
//                                                                       00001060
```

```
PHEASANTS IN PEN 1:      20.     BIRDS DYING IN PEN 1:       0.

PHEASANTS IN PEN 2:       0.     BIRDS DYING IN PEN 2:       0.

PHEASANTS IN PEN 3:       0.     BIRDS DYING IN PEN 3:       0.

PHEASANTS IN PEN 4:       0.     BIRDS DYING IN PEN 4:       0.
PHEASANTS READY TO BE SOLD:       0.     PHEASANTS SOLD THIS WEEK         0.
THE PREVIOUS REPORT WAS FOR WEEK   0.


PHEASANTS IN PEN 1:    2600.     BIRDS DYING IN PEN 1:     400.

PHEASANTS IN PEN 2:       0.     BIRDS DYING IN PEN 2:       0.

PHEASANTS IN PEN 3:       0.     BIRDS DYING IN PEN 3:       0.

PHEASANTS IN PEN 4:       0.     BIRDS DYING IN PEN 4:       0.
PHEASANTS READY TO BE SOLD:       0.     PHEASANTS SOLD THIS WEEK         0.
THE PREVIOUS REPORT WAS FOR WEEK   1.


PHEASANTS IN PEN 1:       0.     BIRDS DYING IN PEN 1:     400.

PHEASANTS IN PEN 2:    2300.     BIRDS DYING IN PEN 2:     300.

PHEASANTS IN PEN 3:       0.     BIRDS DYING IN PEN 3:       0.

PHEASANTS IN PEN 4:       0.     BIRDS DYING IN PEN 4:       0.
PHEASANTS READY TO BE SOLD:       0.     PHEASANTS SOLD THIS WEEK         0.
THE PREVIOUS REPORT WAS FOR WEEK   2.


PHEASANTS IN PEN 1:       0.     BIRDS DYING IN PEN 1:     400.

PHEASANTS IN PEN 2:    2300.     BIRDS DYING IN PEN 2:     300.

PHEASANTS IN PEN 3:       0.     BIRDS DYING IN PEN 3:       0.

PHEASANTS IN PEN 4:       0.     BIRDS DYING IN PEN 4:       0.
PHEASANTS READY TO BE SOLD:       0.     PHEASANTS SOLD THIS WEEK         0.
THE PREVIOUS REPORT WAS FOR WEEK   3.


PHEASANTS IN PEN 1:       0.     BIRDS DYING IN PEN 1:     400.

PHEASANTS IN PEN 2:       0.     BIRDS DYING IN PEN 2:     300.

PHEASANTS IN PEN 3:    2160.     BIRDS DYING IN PEN 3:     140.

PHEASANTS IN PEN 4:       0.     BIRDS DYING IN PEN 4:       0.
PHEASANTS READY TO BE SOLD:       0.     PHEASANTS SOLD THIS WEEK         0.
THE PREVIOUS REPORT WAS FOR WEEK   4.
```

PHEASANTS IN PEN 1: 20. BIRDS DYING IN PEN 1: 400.

PHEASANTS IN PEN 2: 0. BIRDS DYING IN PEN 2: 300.

PHEASANTS IN PEN 3: 2160. BIRDS DYING IN PEN 3: 140.

PHEASANTS IN PEN 4: 0. BIRDS DYING IN PEN 4: 0.
PHEASANTS READY TO BE SOLD: 0. PHEASANTS SOLD THIS WEEK 0.
THE PREVIOUS REPORT WAS FOR WEEK 5.

PHEASANTS IN PEN 1: 2640. BIRDS DYING IN PEN 1: 760.

PHEASANTS IN PEN 2: 0. BIRDS DYING IN PEN 2: 300.

PHEASANTS IN PEN 3: 0. BIRDS DYING IN PEN 3: 140.

PHEASANTS IN PEN 4: 2080. BIRDS DYING IN PEN 4: 80.
PHEASANTS READY TO BE SOLD: 0. PHEASANTS SOLD THIS WEEK 0.
THE PREVIOUS REPORT WAS FOR WEEK 6.

PHEASANTS IN PEN 1: 0. BIRDS DYING IN PEN 1: 760.

PHEASANTS IN PEN 2: 2360. BIRDS DYING IN PEN 2: 580.

PHEASANTS IN PEN 3: 0. BIRDS DYING IN PEN 3: 140.

PHEASANTS IN PEN 4: 2080. BIRDS DYING IN PEN 4: 80.
PHEASANTS READY TO BE SOLD: 0. PHEASANTS SOLD THIS WEEK 0.
THE PREVIOUS REPORT WAS FOR WEEK 7.

PHEASANTS IN PEN 1: 0. BIRDS DYING IN PEN 1: 760.

PHEASANTS IN PEN 2: 2360. BIRDS DYING IN PEN 2: 580.

PHEASANTS IN PEN 3: 0. BIRDS DYING IN PEN 3: 140.

PHEASANTS IN PEN 4: 2080. BIRDS DYING IN PEN 4: 80.
PHEASANTS READY TO BE SOLD: 0. PHEASANTS SOLD THIS WEEK 0.
THE PREVIOUS REPORT WAS FOR WEEK 8.

PHEASANTS IN PEN 1: 20. BIRDS DYING IN PEN 1: 760.

PHEASANTS IN PEN 2: 0. BIRDS DYING IN PEN 2: 580.

PHEASANTS IN PEN 3: 2160. BIRDS DYING IN PEN 3: 340.

PHEASANTS IN PEN 4: 2080. BIRDS DYING IN PEN 4: 80.
PHEASANTS READY TO BE SOLD: 0. PHEASANTS SOLD THIS WEEK 0.
THE PREVIOUS REPORT WAS FOR WEEK 9.

PHEASANTS IN PEN 1: 2520. BIRDS DYING IN PEN 1: 1240.

PHEASANTS IN PEN 2: 0. BIRDS DYING IN PEN 2: 580.

PHEASANTS IN PEN 3: 2160. BIRDS DYING IN PEN 3: 340.

PHEASANTS IN PEN 4: 2080. BIRDS DYING IN PEN 4: 80.
PHEASANTS READY TO BE SOLD: 0. PHEASANTS SOLD THIS WEEK 0.
THE PREVIOUS REPORT WAS FOR WEEK 10.

PHEASANTS IN PEN 1: 0. BIRDS DYING IN PEN 1: 1240.

PHEASANTS IN PEN 2: 2360. BIRDS DYING IN PEN 2: 740.

PHEASANTS IN PEN 3: 0. BIRDS DYING IN PEN 3: 340.

PHEASANTS IN PEN 4: 4100. BIRDS DYING IN PEN 4: 220.
PHEASANTS READY TO BE SOLD: 0. PHEASANTS SOLD THIS WEEK 0.
THE PREVIOUS REPORT WAS FOR WEEK 11.

PHEASANTS IN PEN 1: 0. BIRDS DYING IN PEN 1: 1240.

PHEASANTS IN PEN 2: 2360. BIRDS DYING IN PEN 2: 740.

PHEASANTS IN PEN 3: 0. BIRDS DYING IN PEN 3: 340.

PHEASANTS IN PEN 4: 4100. BIRDS DYING IN PEN 4: 220.
PHEASANTS READY TO BE SOLD: 0. PHEASANTS SOLD THIS WEEK 0.
THE PREVIOUS REPORT WAS FOR WEEK 12.

PHEASANTS IN PEN 1: 20. BIRDS DYING IN PEN 1: 1240.

PHEASANTS IN PEN 2: 0. BIRDS DYING IN PEN 2: 740.

PHEASANTS IN PEN 3: 2220. BIRDS DYING IN PEN 3: 480.

PHEASANTS IN PEN 4: 4100. BIRDS DYING IN PEN 4: 220.
PHEASANTS READY TO BE SOLD: 0. PHEASANTS SOLD THIS WEEK 0.
THE PREVIOUS REPORT WAS FOR WEEK 13.

PHEASANTS IN PEN 1: 2580. BIRDS DYING IN PEN 1: 1660.

PHEASANTS IN PEN 2: 0. BIRDS DYING IN PEN 2: 740.

PHEASANTS IN PEN 3: 2220. BIRDS DYING IN PEN 3: 480.

PHEASANTS IN PEN 4: 4100. BIRDS DYING IN PEN 4: 220.
PHEASANTS READY TO BE SOLD: 0. PHEASANTS SOLD THIS WEEK 0.
THE PREVIOUS REPORT WAS FOR WEEK 14.

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PHEASANTS IN PEN 1:       0.      BIRDS DYING IN PEN 1:    1660.

PHEASANTS IN PEN 2:    2360.      BIRDS DYING IN PEN 2:     960.

PHEASANTS IN PEN 3:       0.      BIRDS DYING IN PEN 3:     480.

PHEASANTS IN PEN 4:    6140.      BIRDS DYING IN PEN 4:     400.
PHEASANTS READY TO BE SOLD:       0.      PHEASANTS SOLD THIS WEEK         0.
THE PREVIOUS REPORT WAS FOR WEEK  15.



PHEASANTS IN PEN 1:       0.      BIRDS DYING IN PEN 1:    1660.

PHEASANTS IN PEN 2:    2360.      BIRDS DYING IN PEN 2:     960.

PHEASANTS IN PEN 3:       0.      BIRDS DYING IN PEN 3:     480.

PHEASANTS IN PEN 4:    6140.      BIRDS DYING IN PEN 4:     400.
PHEASANTS READY TO BE SOLD:       0.      PHEASANTS SOLD THIS WEEK         0.
THE PREVIOUS REPORT WAS FOR WEEK  16.



PHEASANTS IN PEN 1:       0.      BIRDS DYING IN PEN 1:    1660.

PHEASANTS IN PEN 2:       0.      BIRDS DYING IN PEN 2:     960.

PHEASANTS IN PEN 3:    2240.      BIRDS DYING IN PEN 3:     600.

PHEASANTS IN PEN 4:    6140.      BIRDS DYING IN PEN 4:     400.
PHEASANTS READY TO BE SOLD:       0.      PHEASANTS SOLD THIS WEEK         0.
THE PREVIOUS REPORT WAS FOR WEEK  17.



PHEASANTS IN PEN 1:       0.      BIRDS DYING IN PEN 1:    1660.

PHEASANTS IN PEN 2:       0.      BIRDS DYING IN PEN 2:     960.

PHEASANTS IN PEN 3:    2240.      BIRDS DYING IN PEN 3:     600.

PHEASANTS IN PEN 4:    6140.      BIRDS DYING IN PEN 4:     400.
PHEASANTS READY TO BE SOLD:       0.      PHEASANTS SOLD THIS WEEK         0.
THE PREVIOUS REPORT WAS FOR WEEK  18.



PHEASANTS IN PEN 1:       0.      BIRDS DYING IN PEN 1:    1660.

PHEASANTS IN PEN 2:       0.      BIRDS DYING IN PEN 2:     960.

PHEASANTS IN PEN 3:       0.      BIRDS DYING IN PEN 3:     600.

PHEASANTS IN PEN 4:    8200.      BIRDS DYING IN PEN 4:     580.
PHEASANTS READY TO BE SOLD:       0.      PHEASANTS SOLD THIS WEEK         0.
THE PREVIOUS REPORT WAS FOR WEEK  19.
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PHEASANTS IN PEN 1:       0.     BIRDS DYING IN PEN 1:    1660.

PHEASANTS IN PEN 2:       0.     BIRDS DYING IN PEN 2:     960.

PHEASANTS IN PEN 3:       0.     BIRDS DYING IN PEN 3:     600.

PHEASANTS IN PEN 4:    6120.     BIRDS DYING IN PEN 4:     580.
PHEASANTS READY TO BE SOLD:    1680.     PHEASANTS SOLD THIS WEEK       400.
THE PREVIOUS REPORT WAS FOR WEEK  20.


PHEASANTS IN PEN 1:       0.     BIRDS DYING IN PEN 1:    1660.

PHEASANTS IN PEN 2:       0.     BIRDS DYING IN PEN 2:     960.

PHEASANTS IN PEN 3:       0.     BIRDS DYING IN PEN 3:     600.

PHEASANTS IN PEN 4:    6120.     BIRDS DYING IN PEN 4:     580.
PHEASANTS READY TO BE SOLD:    1280.     PHEASANTS SOLD THIS WEEK       400.
THE PREVIOUS REPORT WAS FOR WEEK  21.


PHEASANTS IN PEN 1:       0.     BIRDS DYING IN PEN 1:    1660.

PHEASANTS IN PEN 2:       0.     BIRDS DYING IN PEN 2:     960.

PHEASANTS IN PEN 3:       0.     BIRDS DYING IN PEN 3:     600.

PHEASANTS IN PEN 4:    6120.     BIRDS DYING IN PEN 4:     580.
PHEASANTS READY TO BE SOLD:     880.     PHEASANTS SOLD THIS WEEK       400.
THE PREVIOUS REPORT WAS FOR WEEK  22.


PHEASANTS IN PEN 1:       0.     BIRDS DYING IN PEN 1:    1660.

PHEASANTS IN PEN 2:       0.     BIRDS DYING IN PEN 2:     960.

PHEASANTS IN PEN 3:       0.     BIRDS DYING IN PEN 3:     600.

PHEASANTS IN PEN 4:    6120.     BIRDS DYING IN PEN 4:     580.
PHEASANTS READY TO BE SOLD:     480.     PHEASANTS SOLD THIS WEEK       400.
THE PREVIOUS REPORT WAS FOR WEEK  23.


PHEASANTS IN PEN 1:       0.     BIRDS DYING IN PEN 1:    1660.

PHEASANTS IN PEN 2:       0.     BIRDS DYING IN PEN 2:     960.

PHEASANTS IN PEN 3:       0.     BIRDS DYING IN PEN 3:     600.

PHEASANTS IN PEN 4:    6120.     BIRDS DYING IN PEN 4:     580.
PHEASANTS READY TO BE SOLD:      80.     PHEASANTS SOLD THIS WEEK       400.
THE PREVIOUS REPORT WAS FOR WEEK  24.
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PHEASANTS IN PEN 1:       0.     BIRDS DYING IN PEN 1:    1660.

PHEASANTS IN PEN 2:       0.     BIRDS DYING IN PEN 2:     960.

PHEASANTS IN PEN 3:       0.     BIRDS DYING IN PEN 3:     600.

PHEASANTS IN PEN 4:    4100.     BIRDS DYING IN PEN 4:     580.
PHEASANTS READY TO BE SOLD:    1700.     PHEASANTS SOLD THIS WEEK       400.
THE PREVIOUS REPORT WAS FOR WEEK  25.


PHEASANTS IN PEN 1:       0.     BIRDS DYING IN PEN 1:    1660.

PHEASANTS IN PEN 2:       0.     BIRDS DYING IN PEN 2:     960.

PHEASANTS IN PEN 3:       0.     BIRDS DYING IN PEN 3:     600.

PHEASANTS IN PEN 4:    4100.     BIRDS DYING IN PEN 4:     580.
PHEASANTS READY TO BE SOLD:    1300.     PHEASANTS SOLD THIS WEEK       400.
THE PREVIOUS REPORT WAS FOR WEEK  26.


PHEASANTS IN PEN 1:       0.     BIRDS DYING IN PEN 1:    1660.

PHEASANTS IN PEN 2:       0.     BIRDS DYING IN PEN 2:     960.

PHEASANTS IN PEN 3:       0.     BIRDS DYING IN PEN 3:     600.

PHEASANTS IN PEN 4:    4100.     BIRDS DYING IN PEN 4:     580.
PHEASANTS READY TO BE SOLD:     900.     PHEASANTS SOLD THIS WEEK       400.
THE PREVIOUS REPORT WAS FOR WEEK  27.


PHEASANTS IN PEN 1:       0.     BIRDS DYING IN PEN 1:    1660.

PHEASANTS IN PEN 2:       0.     BIRDS DYING IN PEN 2:     960.

PHEASANTS IN PEN 3:       0.     BIRDS DYING IN PEN 3:     600.

PHEASANTS IN PEN 4:    4100.     BIRDS DYING IN PEN 4:     580.
PHEASANTS READY TO BE SOLD:     500.     PHEASANTS SOLD THIS WEEK       400.
THE PREVIOUS REPORT WAS FOR WEEK  28.


PHEASANTS IN PEN 1:       0.     BIRDS DYING IN PEN 1:    1660.

PHEASANTS IN PEN 2:       0.     BIRDS DYING IN PEN 2:     960.

PHEASANTS IN PEN 3:       0.     BIRDS DYING IN PEN 3:     600.

PHEASANTS IN PEN 4:    2060.     BIRDS DYING IN PEN 4:     580.
PHEASANTS READY TO BE SOLD:    2140.     PHEASANTS SOLD THIS WEEK       400.
THE PREVIOUS REPORT WAS FOR WEEK  29.
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PHEASANTS IN PEN 1:       0.      BIRDS DYING IN PEN 1:    1660.

PHEASANTS IN PEN 2:       0.      BIRDS DYING IN PEN 2:     960.

PHEASANTS IN PEN 3:       0.      BIRDS DYING IN PEN 3:     600.

PHEASANTS IN PEN 4:    2060.      BIRDS DYING IN PEN 4:     580.
PHEASANTS READY TO BE SOLD:    1740.      PHEASANTS SOLD THIS WEEK       400.
THE PREVIOUS REPORT WAS FOR WEEK  30.


PHEASANTS IN PEN 1:       0.      BIRDS DYING IN PEN 1:    1660.

PHEASANTS IN PEN 2:       0.      BIRDS DYING IN PEN 2:     960.

PHEASANTS IN PEN 3:       0.      BIRDS DYING IN PEN 3:     600.

PHEASANTS IN PEN 4:    2060.      BIRDS DYING IN PEN 4:     580.
PHEASANTS READY TO BE SOLD:    1340.      PHEASANTS SOLD THIS WEEK       400.
THE PREVIOUS REPORT WAS FOR WEEK  31.


PHEASANTS IN PEN 1:       0.      BIRDS DYING IN PEN 1:    1660.

PHEASANTS IN PEN 2:       0.      BIRDS DYING IN PEN 2:     960.

PHEASANTS IN PEN 3:       0.      BIRDS DYING IN PEN 3:     600.

PHEASANTS IN PEN 4:    2060.      BIRDS DYING IN PEN 4:     580.
PHEASANTS READY TO BE SOLD:     940.      PHEASANTS SOLD THIS WEEK       400.
THE PREVIOUS REPORT WAS FOR WEEK  32.


PHEASANTS IN PEN 1:       0.      BIRDS DYING IN PEN 1:    1660.

PHEASANTS IN PEN 2:       0.      BIRDS DYING IN PEN 2:     960.

PHEASANTS IN PEN 3:       0.      BIRDS DYING IN PEN 3:     600.

PHEASANTS IN PEN 4:       0.      BIRDS DYING IN PEN 4:     580.
PHEASANTS READY TO BE SOLD:    2600.      PHEASANTS SOLD THIS WEEK       400.
THE PREVIOUS REPORT WAS FOR WEEK  33.


PHEASANTS IN PEN 1:       0.      BIRDS DYING IN PEN 1:    1660.

PHEASANTS IN PEN 2:       0.      BIRDS DYING IN PEN 2:     960.

PHEASANTS IN PEN 3:       0.      BIRDS DYING IN PEN 3:     600.

PHEASANTS IN PEN 4:       0.      BIRDS DYING IN PEN 4:     580.
PHEASANTS READY TO BE SOLD:    2200.      PHEASANTS SOLD THIS WEEK       400.
THE PREVIOUS REPORT WAS FOR WEEK  34.
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PHEASANTS IN PEN 1:       0.     BIRDS DYING IN PEN 1:    1660.

PHEASANTS IN PEN 2:       0.     BIRDS DYING IN PEN 2:     960.

PHEASANTS IN PEN 3:       0.     BIRDS DYING IN PEN 3:     600.

PHEASANTS IN PEN 4:       0.     BIRDS DYING IN PEN 4:     580.
PHEASANTS READY TO BE SOLD:    1800.     PHEASANTS SOLD THIS WEEK       400.
THE PREVIOUS REPORT WAS FOR WEEK  35.


PHEASANTS IN PEN 1:       0.     BIRDS DYING IN PEN 1:    1660.

PHEASANTS IN PEN 2:       0.     BIRDS DYING IN PEN 2:     960.

PHEASANTS IN PEN 3:       0.     BIRDS DYING IN PEN 3:     600.

PHEASANTS IN PEN 4:       0.     BIRDS DYING IN PEN 4:     580.
PHEASANTS READY TO BE SOLD:    1400.     PHEASANTS SOLD THIS WEEK       400.
THE PREVIOUS REPORT WAS FOR WEEK  36.


PHEASANTS IN PEN 1:       0.     BIRDS DYING IN PEN 1:    1660.

PHEASANTS IN PEN 2:       0.     BIRDS DYING IN PEN 2:     960.

PHEASANTS IN PEN 3:       0.     BIRDS DYING IN PEN 3:     600.

PHEASANTS IN PEN 4:       0.     BIRDS DYING IN PEN 4:     580.
PHEASANTS READY TO BE SOLD:    1000.     PHEASANTS SOLD THIS WEEK       400.
THE PREVIOUS REPORT WAS FOR WEEK  37.


PHEASANTS IN PEN 1:       0.     BIRDS DYING IN PEN 1:    1660.

PHEASANTS IN PEN 2:       0.     BIRDS DYING IN PEN 2:     960.

PHEASANTS IN PEN 3:       0.     BIRDS DYING IN PEN 3:     600.

PHEASANTS IN PEN 4:       0.     BIRDS DYING IN PEN 4:     580.
PHEASANTS READY TO BE SOLD:     600.     PHEASANTS SOLD THIS WEEK       400.
THE PREVIOUS REPORT WAS FOR WEEK  38.


PHEASANTS IN PEN 1:       0.     BIRDS DYING IN PEN 1:    1660.

PHEASANTS IN PEN 2:       0.     BIRDS DYING IN PEN 2:     960.

PHEASANTS IN PEN 3:       0.     BIRDS DYING IN PEN 3:     600.

PHEASANTS IN PEN 4:       0.     BIRDS DYING IN PEN 4:     580.
PHEASANTS READY TO BE SOLD:       0.     PHEASANTS SOLD THIS WEEK       600.
THE PREVIOUS REPORT WAS FOR WEEK  39.
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S L A M S U M M A R Y R E P O R T

SIMULATION PROJECT PHEASANT FARM BY BRADLEY

DATE 6/10/1985 RUN NUMBER 1 OF 1

CURRENT TIME 0.3900E+02
STATISTICAL ARRAYS CLEARED AT TIME 0.0000E+00

REGULAR ACTIVITY STATISTICS

ACTIVITY INDEX	AVERAGE UTILIZATION	STANDARD DEVIATION	MAXIMUM UTILIZATION	CURRENT UTILIZATION	ENTITY COUNT
1	26.5128	52.1998	132	0	517
2	24.0513	47.3487	118	0	469
3	22.5128	44.3239	112	0	439
4	147.1795	124.1568	410	0	410

U15799AD FORT - STEP WAS EXECUTED - COND CODE 0000
STEP /FORT / START 85166.0216
STEP /FORT / STOP 85166.0216 CPU OMIN 00.15SEC
U15799AD LKED - STEP WAS EXECUTED - COND CODE 0000
STEP /LKED / START 85166.0216
STEP /LKED / STOP 85166.0218 CPU OMIN 03.13SEC
U15799AD SLAM - STEP WAS EXECUTED - COND CODE 0000
STEP /SLAM / START 85166.0218
STEP /SLAM / STOP 85166.0219 CPU OMIN 02.48SEC
JOB /U15799AD/ START 85166.0216
JOB /U15799AD/ STOP 85166.0219 CPU OMIN 05.76SEC

PROCESSOR TIME ---------0.00188 CPU HOURS @ $1,135.00 --------2.13
PROCESSOR STORAGE ------0.75279 K-BYTE HOURS @ $0.25 --------0.19
SLAM TOTAL PROCESSOR COST -------$2.32

DISK EXCPS ----------------3,353 @ $0.36 PER 1000 ------------1.21
I/O COST (EXCLUDING PRINTER/READER/PUNCH) -------$1.21

TOTAL COST (AFTER $2.12 3RD SHIFT DISCOUNT) ---------$1.41

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BLOCK                                                                                                STATEMENT
NUMBER   *LOC    OPERATION  A,B,C,D,E,F,G,H,I          COMMENTS                                      NUMBER
         *                                                                                 00000070      1
         *PHEASANT FARM                                                                    00000080      2
         *                                                                                 00000090      3
         * EACH ENTITY REPRESENTS A BUNDLE OF 20 PHEASANTS                                 00000100      4
         *                                                                                 00000110      5
         * CHICKS ARE PURCHASED IN LOTS OF 3000 (150 BUNDLES) ON THE 1ST,                  00000120      6
         * 5TH, 9TH, AND 13TH WEEKS.  CHICKS OF A GIVEN AGE WAIT TWO WEEKS                 00000130      7
         * IN PENS 1, 2, AND 3, 14 WEEKS IN PEN FOUR, AND THEN GO TO PEN 5                 00000140      8
         * TO BE SOLD.  EACH PEN REQUIRES A DIFFERENT                                      00000150      9
         * AMOUNT OF FOOD.  EACH PEN HAS A DIFFERENT ATTRITION RATE.                       00000160     10
         *                                                                                 00000170     11
         * BIRDS ARE SOLD IN LOTS OF 400 (20 BUNDLES).  AT THE END                         00000180     12
         * THE BUYER WILL PURCHASE 400 PHEASANTS PLUS ANY ODD                              00000190     13
         * AMOUNT UP TO 800 BIRDS TO CLEAR OUT THE PHEASANT FARM.                          00000200     14
         *       XH1 REPRESENTS BIRDS THAT DIE IN PEN 1                                    00000210     15
         *       XH2 REPRESENTS BIRDS THAT DIE IN PEN 2                                    00000220     16
         *       XH3 REPRESENTS BIRDS THAT DIE IN PEN 3                                    00000230     17
         *       XH4 REPRESENTS BIRDS THAT DIE IN PEN 4                                    00000240     18
         *       XH5 REPRESENTS BIRDS THAT ARE READY TO BE SOLD                            00000250     19
         *       XH6 REPRESENTS BIRDS THAT HAVE BEEN SOLD IN A GIVEN WEEK                  00000260     20
         *                                                                                 00000270     21
         * MSAVEVALUES ARE MATRIX SAVEVALUES                                               00000280     22
         * THEY COUNT BIRDS THAT DIE, ARE SOLD, OR ARE SELLABLE BY WEEK                    00000290     23
               SIMULATE                                                                    00000300     24
         *                                                                                 00000310     25
          1      MATRIX     MH,43,5                                                       00000320     26
          2      MATRIX     MH,43,4                                                       00000330     27
         *                                                                                 00000340     28
1                GENERATE   0,0,,150   MAX OF 150 CREATIONS (BUNDLES)                     00000350     29
2         QUE1   QUEUE      QUE1       A BUNDLE REPRESENTS 20 PHEASANTS                  00000360     30
3                TRANSFER   .12,,DIE1  12% IN FIRST PEN DIE                              00000370     31
4                SAVEVALUE  11+,20,XH                                                    00000380     32
5                ADVANCE    2          TWO WEEKS IN FIRST PEN                            00000390     33
6                SAVEVALUE  11-,20,XH                                                    00000400     34
7                DEPART     QUE1                                                         00000410     35
8                QUEUE      QUE2                                                         00000420     36
9                TRANSFER   .09,,DIE2  9% IN SECOND PEN DIE                             00000430     37
10               SAVEVALUE  12+,20,XH                                                    00000440     38
11               ADVANCE    2                                                            00000450     39
12               SAVEVALUE  12-,20,XH                                                    00000460     40
13               DEPART     QUE2                                                         00000470     41
14               QUEUE      QUE3                                                         00000480     42
15               TRANSFER   .06,,DIE3  6% IN THIRD PEN DIE                              00000490     43
16               SAVEVALUE  13+,20,XH                                                    00000500     44
17               ADVANCE    2                                                            00000510     45
18               SAVEVALUE  13-,20,XH                                                    00000520     46
19               DEPART     QUE3                                                         00000530     47
20               QUEUE      QUE4                                                         00000540     48
21               TRANSFER   .05,,DIE4  5% IN FOURTH PEN DIE                             00000550     49
22               SAVEVALUE  14+,20,XH                                                    00000560     50
23               ADVANCE    14         14 WEEKS ARE SPENT IN FOURTH PEN                  00000570     51
24               SAVEVALUE  14-,20,XH                                                    00000580     52
25               DEPART     QUE4                                                         00000590     53
26               QUEUE      QUE5                                                         00000600     54
27               SAVEVALUE  5+,20,XH    XH5 IS SURVIVING BIRDS                         00000610     55
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28              DEPART     QUE5                                                  00000620   56
29              TERMINATE                BIRDS ARE SOLD AND NO LONGER IN SYSTEM  00000630   57
30        DIE1  DEPART     QUE1                                                  00000640   58
31              SAVEVALUE  1+,20,XH                                              00000650   59
32              TERMINATE                                                        00000660   60
33        DIE2  DEPART     QUE2                                                  00000670   61
34              SAVEVALUE  2+,20,XH   XH1 IS # THAT DIE IN PEN 1                 00000680   62
35              TERMINATE                                                        00000690   63
36        DIE3  DEPART     QUE3                                                  00000700   64
37              SAVEVALUE  3+,20,XH                                              00000710   65
38              TERMINATE                                                        00000720   66
39        DIE4  DEPART     QUE4                                                  00000730   67
40              SAVEVALUE  4+,20,XH                                              00000740   68
41              TERMINATE                                                        00000750   69
          *                                                                      00000760   70
          *                                                                      00000770   71
42              GENERATE   0,0,5,150  GENERATE 150 BUNDLES IN 5 WEEKS           00000780   72
43              TRANSFER   ,QUE1                                                 00000790   73
44              GENERATE   0,0,9,150  GENERATE 150 BUNDLES IN 9 WEEKS           00000800   74
45              TRANSFER   ,QUE1                                                 00000810   75
46              GENERATE   0,0,13,150 GENERATE 150 BUNDLES IN 13 WEEKS         00000820   76
47              TRANSFER   ,QUE1                                                 00000830   77
          *                                                                      00000840   78
          *                                                                      00000850   79
48              GENERATE   1                                                     00000860   80
49              MSAVEVALUE 1,C1,1,XH1,MH     FIELD A IS MATRIX #                 00000870   81
50              MSAVEVALUE 1,C1,2,XH2,MH     FIELD B IS ROW                      00000880   82
51              MSAVEVALUE 1,C1,3,XH3,MH     FIELD C IS COLUMN                   00000890   83
52              MSAVEVALUE 1,C1,4,XH4,MH     FIELD D IS MODIFYING VALUE          00000900   84
53              MSAVEVALUE 1,C1,5,XH5,MH     FIELD E IS HALFWORD MATRIX TYPE     00000910   85
54              MSAVEVALUE 2,C1,1,XH11,MH     C1 IS VALUE OF SIMULATION CLOCK    00000920   86
55              MSAVEVALUE 2,C1,2,XH12,MH     C1 REPRESENTS WEEKS                00000930   87
56              MSAVEVALUE 2,C1,3,XH13,MH     BIRDS IN EACH PEN (BY WEEK)        00000940   88
57              MSAVEVALUE 2,C1,4,XH14,MH                                        00000950   89
58              TERMINATE                                                        00000960   90
          *                                                                      00000970   91
          *                                                                      00000980   92
59              GENERATE   1                                                     00000990   93
60              TEST G     C1,33,AAA        GO TO AAA IF C1 G 33 IS FALSE       00001000   94
61              TEST L     XH5,800,AAB      GO TO AAB IF BIRDS TO SELL L 800 FALSE00001010   95
62              SAVEVALUE  6+,XH5,XH        ADD BIRDS LEFT (XH5) TO SOLD (XH6)  00001020   96
63              SAVEVALUE  5-,XH5,XH        BIRDS JUST SOLD LESS BIRDS LEFT     00001030   97
64              TERMINATE  1                END SIMULATION - ALL BIRDS SOLD     00001040   98
65        AAA   TEST GE    XH5,400,AAC      IF SELLABLE BIRDS < 400, GO TO AAC  00001050   99
66        AAB   SAVEVALUE  6+,400,XH        ADD 400 TO BIRDS SOLD (XH6)         00001060  100
67              SAVEVALUE  6,0,XH           CLEAR WEEKLY BIRDS SOLD COUNTER (XH6) 00001070 101
68              SAVEVALUE  5-,400,XH        SUBTRACT 400 FROM BIRDS LEFT (XH5)  00001080  102
69        AAC   TERMINATE                                                        00001090  103
              START      1                                                     00001100  104
              REPORT                                                           00001110  105
              EJECT                                                            00001120  106
          10  TEXT       PHEASANT FARM                                         00001130  107
              SPACE      4                                                     00001140  108
          10  TEXT       A LISTING OF PHEASANTS PER PEN                        00001150  109
          10  TEXT       AND BIRD LOSSES THROUGH ATTRITION PER PEN.            00001160  110
          10  TEXT       COMPILED WEEKLY.                                      00001170  111
              SPACE      4                                                     00001180  112
```

```
10      TEXT        A MATRIX OF PHEASANTS IN EACH PEN                    00001190        113
10      TEXT        LISTED WEEK (ROW) BY PEN (COLUMN)                    00001200        114
10      TEXT        COLUMNS 1 TO 4 LIST PEN NUMBERS                      00001210        115
        SPACE       4                                                    00001220        116
MHSA    TITLE       , PHEASANTS PER WEEK (ROW) PER PEN (COLUMN)          00001230        117
MHSA    INCLUDE     2/MH1-MH4                                            00001240        118
        EJECT                                                            00001250        119
        SPACE       4                                                    00001260        120
10      TEXT        A MATRIX OF PHEASANTS THAT DIE THROUGH ATTRITION     00001270        121
10      TEXT        AND ARE READY TO SELL, COMPILED BY WEEK.             00001280        122
        SPACE       4                                                    00001290        123
10      TEXT        COLUMNS 1 TO 4 LIST CUMULATIVE BIRDS THAT DIE        00001300        124
10      TEXT        COLUMN 5 LISTS BIRDS THAT ARE READY TO SELL          00001310        125
        SPACE       4                                                    00001320        126
MHSA    TITLE       , BIRDS DYING (1-4) AND READY TO SELL (5)            00001330        127
MHSA    INCLUDE     1/MH1-MH5                                            00001340        128
        OUTPUT                                                           00001350        129
        END                                                                              130
```

PHEASANT FARM

A LISTING OF PHEASANTS PER PEN
AND BIRD LOSSES THROUGH ATTRITION PER PEN.
COMPILED WEEKLY.

A MATRIX OF PHEASANTS IN EACH PEN
LISTED WEEK (ROW) BY PEN (COLUMN)
COLUMNS 1 TO 4 LIST PEN NUMBERS

PHEASANTS PER WEEK (ROW) PER PEN (COLUMN)
HALFWORD MATRIX 2

ROW/COLUMN	1	2	3	4
1	20	0	0	0
2	2660	0	0	0
3	0	2380	0	0
4	0	2380	0	0
5	20	0	2260	0
6	2540	0	2260	0
7	0	2300	0	2120
8	0	2300	0	2120
9	20	0	2160	2120
10	2580	0	2160	2120
11	0	2320	0	4240
12	0	2320	0	4240
13	20	0	2140	4240
14	2660	0	2140	4240
15	0	2340	0	6300
16	0	2340	0	6300
17	0	0	2160	6300
18	0	0	2160	6300
19	0	0	0	8340
20	0	0	0	8340
21	0	0	0	6220
22	0	0	0	6220
23	0	0	0	6220
24	0	0	0	6220
25	0	0	0	4100
26	0	0	0	4100
27	0	0	0	4100
28	0	0	0	4100
29	0	0	0	2040
30	0	0	0	2040
31	0	0	0	2040
32	0	0	0	2040
	ROWS 33-43, COLUMNS 1-4 ARE ZERO			

A MATRIX OF PHEASANTS THAT DIE THROUGH ATTRITION
AND ARE READY TO SELL, COMPILED BY WEEK.

COLUMNS 1 TO 4 LIST CUMULATIVE BIRDS THAT DIE
COLUMN 5 LISTS BIRDS THAT ARE READY TO SELL

BIRDS DYING (1-4) AND READY TO SELL (5)
HALFWORD MATRIX 1

ROW/COLUMN	1	2	3	4	5
1	0	0	0	0	0
2	340	0	0	0	0
3	340	280	0	0	0
4	340	280	0	0	0
5	340	280	120	0	0
6	800	280	120	0	0
7	800	520	120	140	0
8	800	520	120	140	0
9	800	520	260	140	0
10	1220	520	260	140	0
11	1220	780	260	180	0
12	1220	780	260	180	0
13	1220	780	440	180	0
14	1560	780	440	180	0
15	1560	1100	440	260	0
16	1560	1100	440	260	0
17	1560	1100	620	260	0
18	1560	1100	620	260	0
19	1560	1100	620	380	0
20	1560	1100	620	380	0
21	1560	1100	620	380	2120
22	1560	1100	620	380	1720
23	1560	1100	620	380	1320
24	1560	1100	620	380	920
25	1560	1100	620	380	2640
26	1560	1100	620	380	2240
27	1560	1100	620	380	1840
28	1560	1100	620	380	1440
29	1560	1100	620	380	3100
30	1560	1100	620	380	2700
31	1560	1100	620	380	2300
32	1560	1100	620	380	1900
33	1560	1100	620	380	3540
34	1560	1100	620	380	3140
35	1560	1100	620	380	2740
36	1560	1100	620	380	2340
37	1560	1100	620	380	1940
38	1560	1100	620	380	1540
39	1560	1100	620	380	1140
40	1560	1100	620	380	740

ROWS 41-43, COLUMNS 1-5 ARE ZERO

RELATIVE CLOCK 40 ABSOLUTE CLOCK 40

BLOCK COUNTS

BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL
1	0	150	11	0	467	21	0	436	31	0	78	41	0	19
2	0	600	12	0	467	22	0	417	32	0	78	42	0	150
3	0	600	13	0	467	23	0	417	33	0	55	43	0	150
4	0	522	14	0	467	24	0	417	34	0	55	44	0	150
5	0	522	15	0	467	25	0	417	35	0	55	45	0	150
6	0	522	16	0	436	26	0	417	36	0	31	46	0	150
7	0	522	17	0	436	27	0	417	37	0	31	47	0	150
8	0	522	18	0	436	28	0	417	38	0	31	48	0	40
9	0	522	19	0	436	29	0	417	39	0	19	49	0	40
10	0	467	20	0	436	30	0	78	40	0	19	50	0	40

BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL	BLOCK	CURRENT	TOTAL
51	0	40	61	0	7									
52	0	40	62	0	1									
53	0	40	63	0	1									
54	0	40	64	0	1									
55	0	40	65	0	33									
56	0	40	66	0	19									
57	0	40	67	0	19									
58	0	40	68	0	19									
59	0	40	69	0	39									
60	0	40												

CPU OMIN 00.86SEC

PROCESSOR TIME ---------0.00033 CPU HOURS @ $1,135.00 --------0.37
PROCESSOR STORAGE ------0.04969 K-BYTE HOURS @ $0.25 --------0.01
GPSS TOTAL PROCESSOR COST -------$0.38
DISK EXCPS ----------622 @ $0.36 PER 1000 ----------0.22
I/O COST (EXCLUDING PRINTER/READER/PUNCH) -------$0.22

TOTAL COST (AFTER $0.36 3RD SHIFT DISCOUNT) ---------$0.24

HALFWORD SAVEVALUES

NUMBER	CONTENTS	NUMBER	CONTENTS	NUMBER	CONTENTS	NUMBER	CONTENTS	NUMBER	CONTENTS	NUMBER	CONTENTS
1	1560	2	1100	3	620	4	380	6	740		

QUEUES

QUEUE	MAXIMUM CONTENTS	AVERAGE CONTENTS	TOTAL ENTRIES	ZERO ENTRIES	PERCENT ZEROS	AVERAGE TIME/TRANS	$AVERAGE TIME/TRANS	TABLE NUMBER	CURRENT CONTENTS
QUE1	133	26.099	600	78	12.9	1.739	2.000		
QUE2	119	23.349	522	55	10.5	1.789	2.000		
QUE3	113	21.799	467	31	6.6	1.867	2.000		
QUE4	417	145.949	436	19	4.3	13.389	14.000		
QUE5	1	.000	417	417	100.0	.000	.000		

$AVERAGE TIME/TRANS = AVERAGE TIME/TRANS EXCLUDING ZERO ENTRIES

APPENDIX B
CHI-SQUARE CALCULATIONS

A TABLE OF OBSERVED AND ESTIMATED EXPECTED CELL COUNTS

	GPSS					SLAM			
CELL	OB-SERVED	EX-PECTED	<Z<		#	OB-SERVED	EX-PECTED	<Z<	
(- ,190)	6	2.99		-2.74	1	4	4.12		-2.63
(190,210)	6	8.47	-2.74	-2.26	2	8	10.25	-2.63	-2.17
(210,230)	30	24.65	-2.26	-1.78	3	32	27.40	-2.17	-1.71
(230,250)	54	57.11	-1.78	-1.30	4	53	57.67	-1.71	-1.26
(250,270)	94	105.26	-1.30	- .82	5	120	103.56	-1.26	- .80
(270,290)	166	154.85	- .82	- .34	6	141	148.49	- .80	- .34
(290,310)	189	181.81	- .34	.14	7	153	173.30	- .34	.12
(310,330)	156	170.16	.14	.62	8	177	164.11	.12	.58
(330,350)	137	127.02	.62	1.10	9	126	126.26	.58	1.04
(350,370)	66	75.69	1.10	1.58	10	71	77.69	1.04	1.49
(370,390)	46	35.35	1.58	2.05	11	51	40.72	1.49	1.95
(390,410)	9	13.96	2.05	2.53	12	15	16.86	1.95	2.41
(410,)	4	5.49	2.53		13	7	7.66	2.41	
TOTAL	963					958			
	12.08					11.10			
^{2}	304.252					304.80			
	41.728					43.64			

The OBSERVED column lists the number of entities having a check out time which falls between the corresponding CELL limits. The EXPECTED column lists the numbers of entities that fall between the CELL limits for a perfectly normal curve having a and which correspond to the respective SLAM or GPSS values. Z represents the value of the standard normal density function.

VITA

Randolph Lewis Bradley

Candidate for the Degree of

Master of Business Administration

Report: A SIGHT VALIDATION OF GPSS AND SLAM II

Major Field: Business Administration

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