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**TRAFFIC SAFETY DEMONSTRATION PROGRAM  
MODELING SYSTEM  
VOLUME II: System Manual**

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16. Abstract <b>ACQUISITIONS</b> The Traffic Safety Demonstration Program Modeling System (DEMON) is an interactive computer model for use in the analysis of individual NHTSA demonstration projects. Ongoing projects are currently being analyzed using this system, and new or alternative concepts may also be modeled. Volume I of this report is a technical summary of the modeling system. Volume II of this report documents the DEMON system access, and mathematical assumptions made. Volume III documents a specialized model of the use of Citizens Band radio by highway patrol. Appendices are given in Volume IV.  This volume describes the DEMON operating system. Pre-set or newly derived data files are called by DEMON to study new options of varying the target groups being studied, increasing or decreasing costs and workload associated with sequences of countermeasures. Recidivism estimates are made so that statistical analysis of proposed project impact may be conducted. DEMON computes sample sizes obtained and, alternatively, those required to assess impact within desired confidence bounds. The system is highly interactive and was designed for a noncomputer-oriented user.					
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## METRIC CONVERSION FACTORS

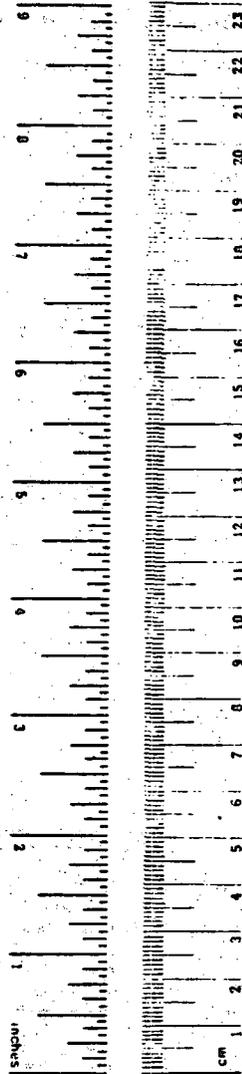
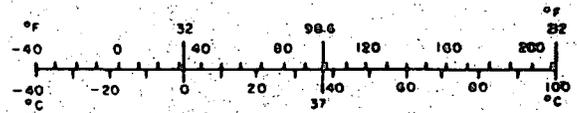
### Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
<b>LENGTH</b>				
in	inches	2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
<b>AREA</b>				
m <sup>2</sup>	square inches	6.5	square centimeters	cm <sup>2</sup>
ft <sup>2</sup>	square foot	0.09	square meters	m <sup>2</sup>
yd <sup>2</sup>	square yards	0.8	square meters	m <sup>2</sup>
mi <sup>2</sup>	square miles	2.6	square kilometers	km <sup>2</sup>
	acres	0.4	hectares	ha
<b>MASS (weight)</b>				
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
<b>VOLUME</b>				
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft <sup>3</sup>	cubic feet	0.03	cubic meters	m <sup>3</sup>
yd <sup>3</sup>	cubic yards	0.76	cubic meters	m <sup>3</sup>
<b>TEMPERATURE (exact)</b>				
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

\*Fig. 2-54 (cont'd). For other exact conversions, and more detailed tables, see: *Metric Units, Part 1, Units of Length and Measure*, Para. 2-55, SO Catalog No. 11-110-28.

### Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
<b>LENGTH</b>				
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
<b>AREA</b>				
cm <sup>2</sup>	square centimeters	0.16	square inches	in <sup>2</sup>
m <sup>2</sup>	square meters	1.2	square yards	yd <sup>2</sup>
km <sup>2</sup>	square kilometers	0.4	square miles	mi <sup>2</sup>
ha	hectares (10,000 m <sup>2</sup> )	2.5	acres	
<b>MASS (weight)</b>				
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
<b>VOLUME</b>				
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.05	quarts	qt
l	liters	0.26	gallons	gal
m <sup>3</sup>	cubic meters	35	cubic feet	ft <sup>3</sup>
m <sup>3</sup>	cubic meters	1.3	cubic yards	yd <sup>3</sup>
<b>TEMPERATURE (exact)</b>				
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



CONTENTS

I	PURPOSE OF THE MODEL . . . . .	1
	A. NHTSA Requirements . . . . .	1
	B. Modeling Technique Selected . . . . .	2
II	MODELING TECHNIQUE . . . . .	7
	A. Preprocessing Routine to Determine Increased Target Group Arrests . . . . .	7
	1. Assumptions . . . . .	7
	2. Deterrence Concept . . . . .	10
	3. Arrest Concept . . . . .	14
	4. Computation of Crashes . . . . .	15
	5. Cost Effectiveness . . . . .	17
	B. Modeling Demonstration Projects . . . . .	17
	1. Flow Calculations . . . . .	17
	2. Countermeasure Stage Types . . . . .	19
	3. Stage Linkage . . . . .	39
	4. Input Data . . . . .	41
	C. Postprocessing Routine to Evaluate Impact . . . . .	42
	1. Notation . . . . .	44
	2. Hypothesis Testing . . . . .	46
	3. Size and Power . . . . .	47
	4. Statistical Tests . . . . .	49
	5. Computation of Test Power . . . . .	49
	6. Computation of Sample Size . . . . .	51
III	INTERACTIVE SYSTEM . . . . .	53
	A. System Access . . . . .	53
	B. Enforcement . . . . .	55
	1. Population Parameters . . . . .	55
	2. Deterrence Parameters . . . . .	56
	3. Accident Rate Parameters . . . . .	57
	4. Enforcement Parameters . . . . .	57
	5. Cost Parameters . . . . .	58
	6. Enforcement Output . . . . .	58

C.	Treatment Programs . . . . .	59
1.	Retrieving Data Files . . . . .	59
2.	Groupings . . . . .	61
3.	Changing the Test Case. . . . .	62
4.	Operations Output . . . . .	77
5.	Statistical Testing on Recidivism or Test Score Data. . . . .	86
6.	Saving Interactively Created Test Cases . . . . .	92
7.	Copy and Rerun Options. . . . .	92
8.	Logoff Procedure. . . . .	94
IV	DATA FILE CONSTRUCTION. . . . .	95
A.	Entering a New Project File. . . . .	96
B.	Modification of an Existing Data File. . . . .	97
C.	Data Files and Format. . . . .	99

LIST OF FIGURES

Figure 1	DEMONSTRATION PROJECT . . . . .	5
Figure 2	DEMON STAGE TYPES . . . . .	20

LIST OF TABLES

Table 1	AVERAGE NUMBER OF DRIVERS IN A CATEGORY BY PHASE	16
Table 2	DATA FILE FORMAT. . . . .	100

## I PURPOSE OF THE MODEL

This project had as its basic objective the development of an interactive computer model that could be used to estimate the operational characteristics and impact of a proposed National Highway Traffic Safety Administration (NHTSA) demonstration project. The model was to be used prior to project implementation and then to update the estimation, as the project planning and operational phases proceed. As an aid to planning and management, the analyst should be able to vary the proposed project's assumptions and data and to compare results in terms of cost, workloads and other factors. Project sample size requirements, and impact measures such as crash reduction, reduction in recidivism, or improvement in test scores, should also be able to be evaluated.

Volume I of this report is a general summary of the model concept with an example application. This volume, Volume II, is a detailed manual giving mathematical rationale and computer instructions. If the reader's interest is to determine whether or not the model would be applicable to a problem, the authors suggest that Volume I be read. If the reader is interested in mathematical assumptions, Section II of this volume should be read. If the user has interest in using the model, without great attention to technical details, the authors suggest reading Volume I, then proceeding directly to Section III of this volume.

### A. NHTSA Requirements

The NHTSA's Office of Driver & Pedestrian Programs (ODPP) has responsibility for the implementation and management of countermeasure demonstration programs. Elements of these demonstration programs consist of combinations of enforcement, adjudication, screening, rehabilitation, and public information and education countermeasures. Each year ODPP conceives and funds specialized traffic safety demonstration projects to be implemented at the

state and local community level. Each project consists of a countermeasure or a group of countermeasures which, hopefully, will have impact on some ultimate criterion measure such as fatal or injury crashes.

The purpose of this study was to develop a computer modeling capability so that the elements of demonstration project planning and design could be expedited and made more comprehensive. This modeling capability could be used to examine possible alternatives under assumed or known parameter settings. The modeling system requirements were that it be:

- Developed on a modular basis for each countermeasure area associated with traffic safety programs.
- Able to generate workload performance and cost data at each countermeasure mode of the system.
- Capable of bypassing countermeasures modules if not included in the demonstration project.
- Sensitive to variation within a configuration strategy as well as between alternative strategies.
- Capable of simulating real time processing through the system considering program impact and recycling of clients through the countermeasure modes.
- Capable of generating estimates of recidivism and measure ultimate project impact over the demonstration period.

The modeling system was to be designed for non-computer oriented users such as traffic safety planners and was to be utilized from a remote terminal operation, in an interactive, conversational mode.

#### B. Modeling Technique Selected

The computer model developed by SRI to meet these needs is named DEMON for Traffic Safety DEMONstration Model and was derived in part from the JUSSIM simulation developed at Carnegie Mellon Institute.<sup>1</sup> DEMON has

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<sup>1</sup> Described in the report entitled, "JUSSIM: An Interactive Computer Program for Analysis of Criminal Justice Systems," by J. Belkin, A. Blumstein and W. Glass, Carnegie-Mellon University, Urban Systems Institute, Pittsburgh, Pa. (July 1974).

been used to evaluate current NHTSA demonstration projects and future projects yet in the conceptual stages. The interactive capability is designed so as to put a minimum burden on the user in terms of operating know-how and data input requirements. The user can readily perform sensitivity studies by making rapid repetitive runs for the range of data under evaluation.

In sum, the main analytical uses of the computer model are as follows:

- o To provide basic project structures for the user to evaluate or modify, or to permit the user to develop a new structure.
- o To evaluate a project in terms of the number of individuals (by control, experimental and other designated groupings) that are processed through each node of the project's flow network representation.
- o To compare alternative results of a project as a function of variations in the input data (e.g., costs, length of project, worker availabilities, etc.) and project assumptions (e.g., effectiveness of treatment programs, recidivism rates, etc.).
- o To perform statistical testing with respect to the measured differences between the control and experimental groups.
- o To determine sample size and other changes (e.g., rate of persons arrested) required to produce the desired project results.
- o To develop cost-effectiveness comparisons for a range of possible project operational plans.
- o To update the procedures as actual data are available.

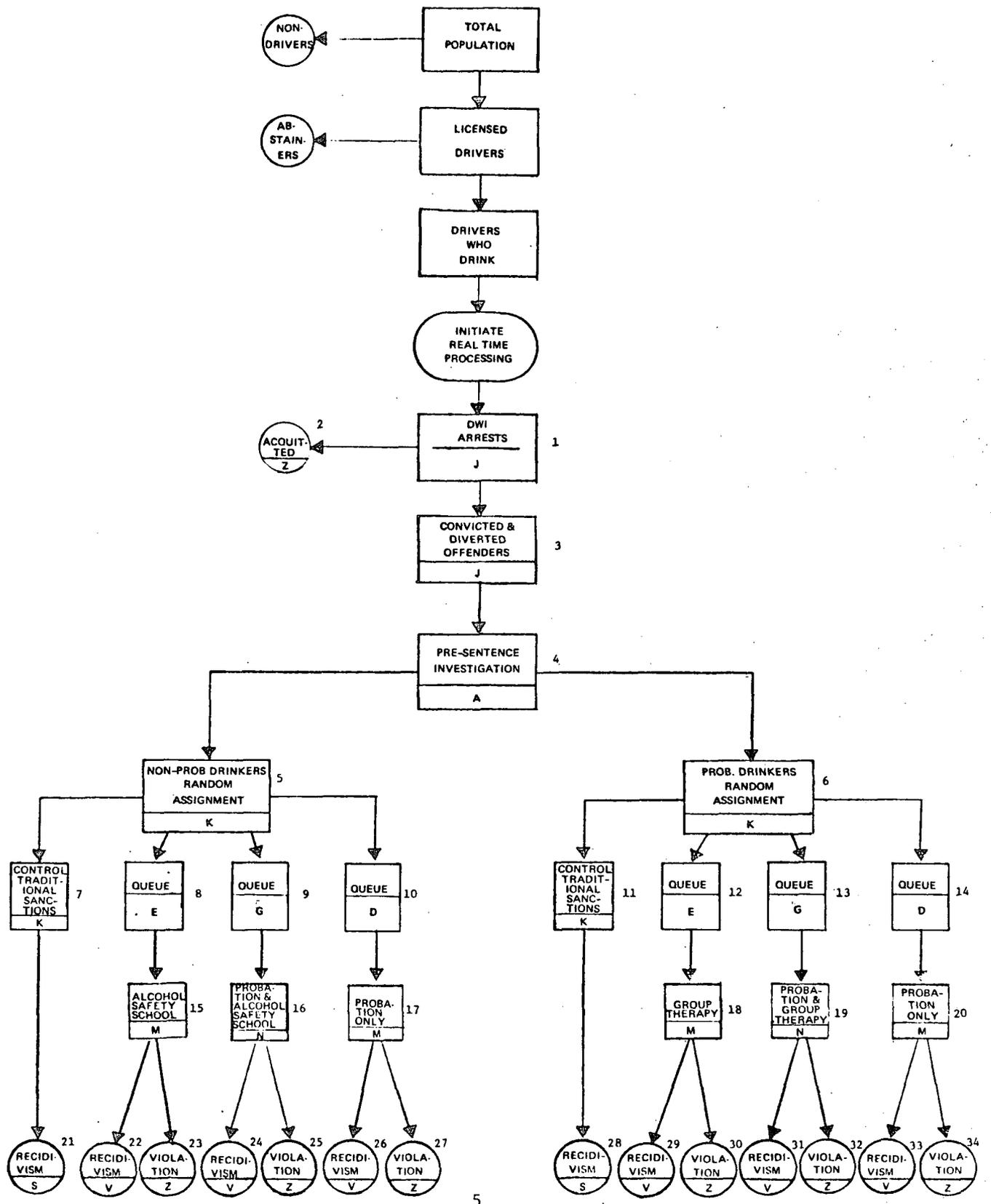
Although NHTSA demonstration projects encompass a diverse range of activities (enforcement, probation, court, education, etc.), the structure and purposes of most projects are quite similar. From a modeling point of view, the form is that of a network flow model consisting of branches and nodes. Individuals are moved from one node, or stage, to another along connecting branches based on given transition probabilities and timing requirements. The model enables the planner to separate and stratify

control and experimental groups, to compare resultant costs, and to determine sample sizes required for evaluation of treatments. Initialization of a computer run requires statements by the user as to how the general population is to be grouped and tracked based on assignment to treatment groups and demographic and personal characteristics.

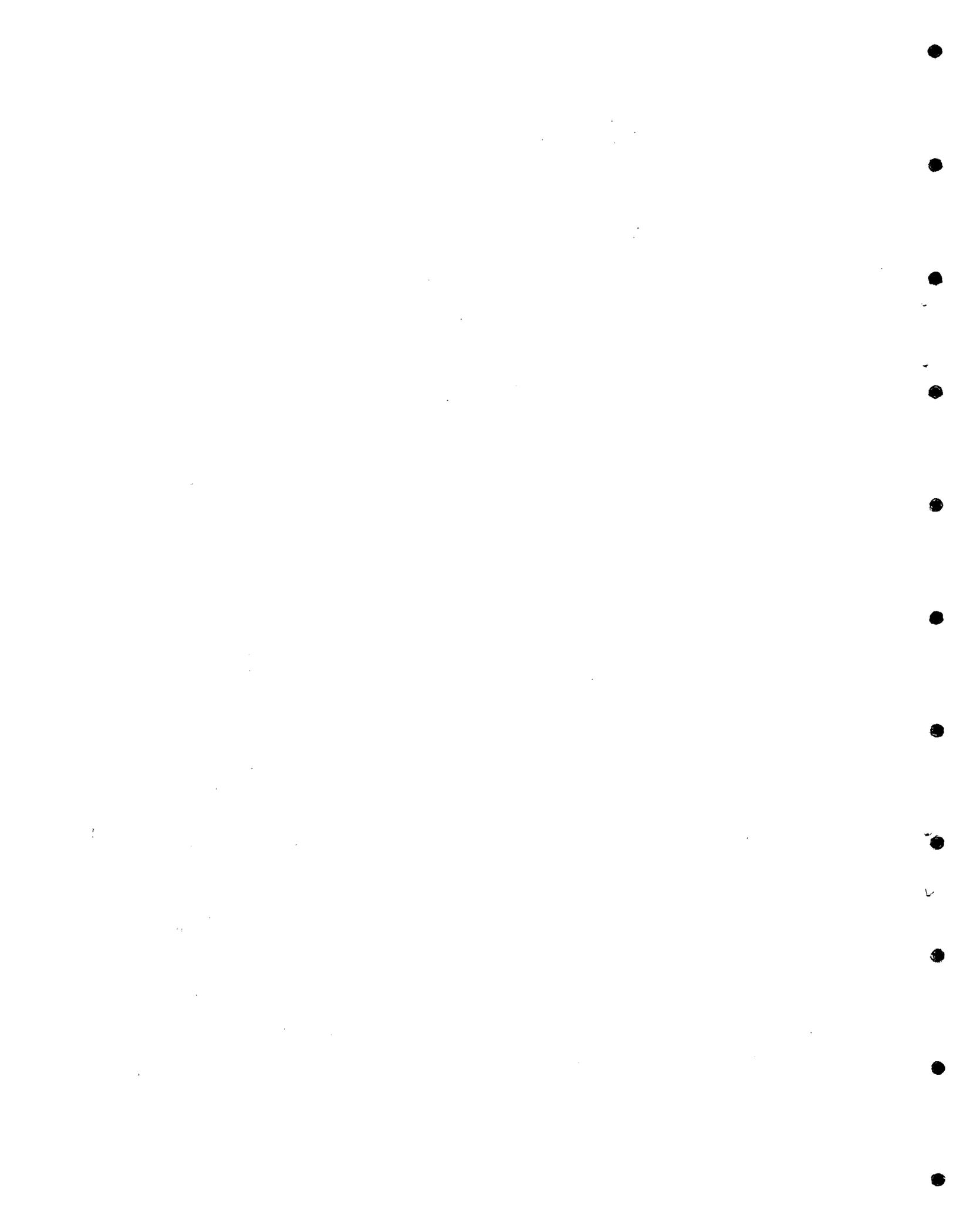
A project flow structure of the type that can be analyzed by the model is illustrated in Figure 1. This type of stage by stage flow structure is typical of most NHTSA demonstration projects.

In this project, the individuals selected for study are licensed drivers who have been arrested for DWI and were not acquitted. After a presentence investigation to determine whether an individual is a problem drinker, an individual is randomly assigned to queue for admittance to one of three treatment modalities or assigned directly to a control group. Individuals who do not violate the terms of their treatment modalities are monitored for recidivism, in this case, repeat DWI offenses.

For another application, the number of stages and project structure will vary from this one. The numbering on stages denotes the order of the structure and the letters for the stages denote the type of activity. Data files already prepared for the user for several projects contain both the structure and the stage parameters and are given in Volume IV of this report. Using a prepared data file, changes to the data may be made interactively. One NHTSA project, A Citizens Band Radio project, differs markedly from this network structure and is discussed separately in Volume III of this report.



5  
 PROBATION  
 Figure 1



## II MODELING TECHNIQUE

The DEMON model can be most simply described as an expected value, network flow model. Target groups may be studied and derived. Once target groups are generated, individuals enter into a system consisting of various stages of group allocation and treatment. Flow from various treatment and control groups is used to calculate recidivism behavior that follows these activities. Statistical tests are made to determine treatment effects on future offenses.

In this section of the report, first a preprocessing routine for deriving a target group is discussed, then the method of modeling a demonstration project on that target group and finally a postprocessing routine for evaluating the project's effects.

### A. Preprocessing Routine to Determine Increased Target Group Arrests

Since many NHTSA projects involve task force arrest patrols, and since many target group flow rates are arrest rates, it may be difficult to plan a project based on an existing arrest rate; the actual demonstration project rate may be higher at first, and eventually lower. For this reason an enforcement routine was added to provide the user with a preliminary assessment of possible arrest and deterrence effects. The routine is described below.

#### 1. Assumptions

In the enforcement routine, two areas of a jurisdiction having similar characteristics, called Area A and Area B, are selected. A task force of officers is first assigned to Area A to increase DWI surveillance and apprehension. This effort is assumed to be supplemented by an intensive public information campaign. This is Phase I. For Phase II, the task force moves to Area B, repeating the procedure for the same

length of time. A control period is also calculated for a time equivalent to Phase I (also equivalent to Phase II) to determine effects with no program.

Further assumptions for the routine are as follows. First, each area, A or B, has four categories of individuals--non-drinkers (do not ever drink and drive), deterred drinkers (do not drink and drive because of the program), drinking drivers who are arrested by the task force, and drinking drivers who are not arrested by the task force. Each such category has a crash rate. People may move from category to category during the project. For example, a drinking driver may become a deterred drinker and a non-arrest drinking driver may eventually be arrested. The model counts crashes by category, i.e., the crashes which people had while they were in a particular category are counted. This calculation is made according to category crash rates and the number of individuals in a category over time.

In Area A, Phase I, all categories are possible since the task force unit is in this area. In Phase II, Area A task force arrest category is excluded because the task force is in Area B. In Area A, Phase II, deterred drinkers remain due to Phase I task force effects and the public information campaign. Phase II is continued for the same time period as that for Phase I. In the control for Area A, there are no deterred drinkers or task force arrests since no program effects are assumed. The control period has equal length to that of each Phase.

Area B, Phase I has all but task force arrests, with the deterrence group attributable to public information only. In Phase II, Area B, task force arrests are then added. The control is similar to that for Area A--no program effects for an equal time period.

In order to discuss the calculations involved we first list the input data:

o General Input Data:

- h = number of task force units (dimensionless)
- $\lambda$  = rate drinking drivers can be observed (people/hour)
- $\mu$  = booking rate (people/hour)
- w = hours per work week per task force unit (hours/week)
- c = cost of one task force unit for one hour (\$/hour)
- T = total project operation time, Phase I plus Phase II (weeks)

o Area Specific Input Data

Area A

Area B

- Deterrence Data:

$x_a$  = maximum percent deterrence with public information and task force enforcement, reached at  $t_{x_a}$

$x_b$  = maximum percent deterrence with public information and task force enforcement, reached at  $t_{x_b}$

$t_{x_a}$  = time  $x_a$  is obtained

$t_{x_b}$  = time  $x_b$  is obtained

$y_a$  = maximum percent deterrence with public information only, reached at  $t_{y_a}$

$y_b$  = maximum percent deterrence with public information only, reached at  $t_{y_b}$

$t_{y_a}$  = time  $y_a$  is obtained

$t_{y_b}$  = time  $y_b$  is obtained

- Population Data:

$L_A$  = no. of licensed drivers in Area A

$L_B$  = no. of licensed drivers in Area B

$d_A$  = proportion of drinking drivers

$d_B$  = proportion of drinking drivers

Area A

Area B

- Crash Rate Data (accidents/person/year)

$A_{ND}$  = Crash rates for non-drinkers

$B_{ND}$  = Crash rates for non-drinkers

$A_D$  = Crash rates for deterred drinkers

$B_D$  = Crash rates for deterred drinkers

$A_{NA}$  = Crash rate, drinker, no arrest

$B_{NA}$  = Crash rate, drinker, no arrest

$A_A$  = Crash rate, drinker, arrested

$B_A$  = Crash rate, drinker, arrested

The enforcement routine has two important concepts: deterrence and arrest. The deterrence concept is that individuals are affected according to exponential distributions (learning curves) for public information alone and in combination with increased arrest. The arrest concept draws from queuing theory methods of examining a large customer population (drinking drivers) with a limited queue length (number of task force units).

2. Deterrence Concept

The concept deals with the change over time of the probability of deterring the drinking driver. We assume that a deterrence effect is specified by 1) a time at which maximum deterrence is reached,  $t$ ; 2) the maximum proportion of the drinking/driver population which can be deterred,  $x$ ; and 3) a relationship

$$x = 1 - e^{-\alpha t}$$

where  $\alpha$  is such that a probability distribution is defined, i.e.,

$$\text{Prob (deterred by time } t) = 1 - e^{-\alpha t}, \quad \alpha \geq 0.$$

The user supplies  $t$  and  $x$ , and  $\alpha$  is computed. This enables a probability of deterrence to be defined for any time after program commencement.

We assume that in Area A, Phase I, a public information effort plus arrest visibility results in a probability of deterrence curve, increasing with time, up to some maximum value. In Phase II, Area A,

the curve works in reverse, decreasing with time, exactly as it had increased, but never decreasing below the public information only deterrence curve at any point in time. For Area B, Phase I, a public information only curve is followed and at the outset of Phase II increases from its current position up a public information and arrest visibility curve.

There are many situations to consider depending on whether or not a maximum deterrence proportion is reached before the phase is completed. The assumption that maximum deterrence time is always less than the time period of a phase was made to simplify computations, and has given no problems to users to date.

We are given as input  $T =$  time period of Phase I plus Phase II and  $(x_a, t_{x_a}), (y_a, t_{y_a}), (x_b, t_{x_b}), (y_b, t_{y_b})$ .

During Phase I the rate of deterrence in Area A is given by

$$f_a(t) = \begin{cases} 1 - e^{-\alpha_a t} & \text{for } t < t_{x_a} \\ x_a & \text{for } t_{x_a} \leq t \leq \frac{T}{2} \end{cases}$$

In Area B the rate of deterrence is

$$f_b(t) = \begin{cases} 1 - e^{-\beta_b t} & \text{for } t < t_{y_b} \\ y_b & \text{for } t_{y_b} \leq t \leq \frac{T}{2} \end{cases}$$

We have assumed  $t_{x_a}$  and  $t_{y_b}$  to be both less than or equal to  $\frac{T}{2}$ , the length of a phase. The functions  $f_a(t)$  and  $f_b(t)$  are continuous so that

$$f_a(t_{x_a}) = 1 - e^{-\alpha_a t_{x_a}} = x_a$$

and

$$f_b(t_{y_b}) = 1 - e^{-\beta_b t_{y_b}} = y_b$$

Thus, we can solve for the unknown quantities  $\alpha_a$  and  $\beta_b$

$$\alpha_a = - \frac{\ln(1 - x_a)}{t_{x_a}}$$

and

$$\beta_b = - \frac{\ln(1 - y_b)}{t_{y_b}}$$

In Phase II we assume that when the enforcement effort in Area A stops, the rate of deterrence falls gradually from  $x_a$  to  $y_a$ , while in Area B the rate of deterrence rises with increased enforcement from  $y_b$  to  $x_b$  according to

$$f_a(t) = \begin{cases} 1 - e^{-\alpha_a \left( t_{x_a} - t + \frac{T}{2} \right)} & \frac{T}{2} < t < \frac{T}{2} + t_{x_a} - t_{xy_a} \\ y_a & \frac{T}{2} + t_{x_a} - t_{xy_a} \leq t \leq T \end{cases}$$

$$f_b(t) = \begin{cases} 1 - e^{-\alpha_b \left( t - \frac{T}{2} + t_{xy_b} \right)} & \frac{T}{2} < t < \frac{T}{2} + t_{x_b} - t_{xy_b} \\ x_b & \frac{T}{2} + t_{x_b} - t_{xy_b} \leq t \leq T \end{cases}$$

where

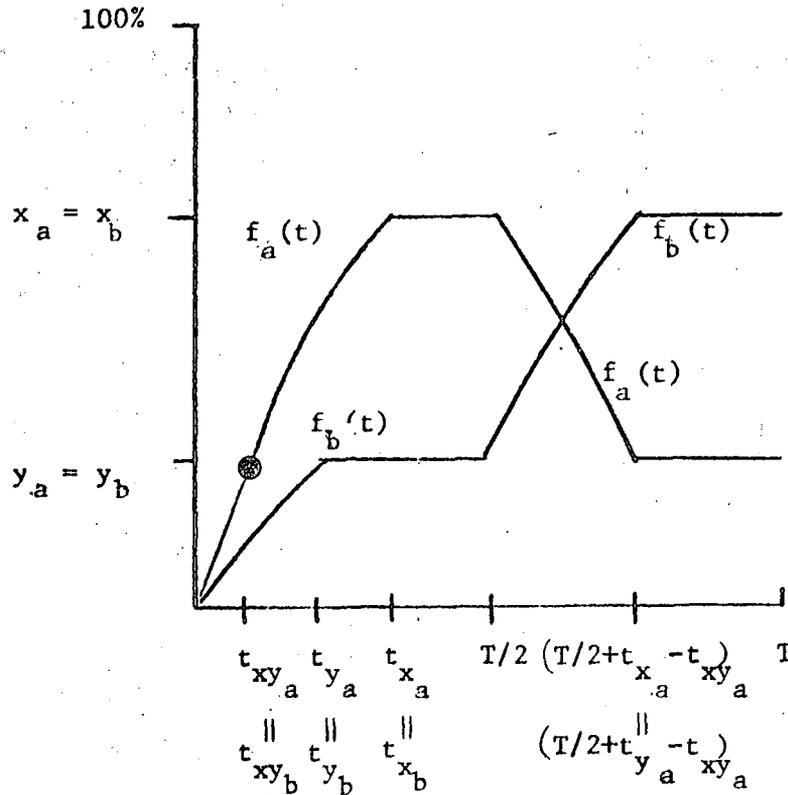
$$\alpha_b = - \frac{\ln(1 - x_b)}{t_{x_b}}$$

$$t_{xy_a} = \frac{\ln(1 - y_a) t_{x_a}}{\ln(1 - x_a)}$$

$$t_{xy_b} = \frac{\beta_b t_{y_b}}{\alpha_b}$$

$f_a(t)$  and  $f_b(t)$  are shown graphically below for the case

$$t_{x_a} = t_{x_b}, \quad x_a = x_b, \quad t_{y_a} = t_{y_b}, \quad y_a = y_b.$$



This graph assumes the same deterrence effects in Areas A and B. The model can account for differences in deterrence for the two areas.

The time-average proportion of people deterred in each area during each phase is then given by

For Area A, Phase I:

$$P_A(I) = \frac{2}{T} \int_0^{T/2} f_a(t) dt = \frac{2}{T} \left[ t_{x_a} - \frac{x_a}{\alpha_a} + x_a \left( \frac{T}{2} - t_{x_a} \right) \right]$$

For Area A, Phase II:

$$P_A(II) = \frac{2}{T} \int_{T/2}^T f_a(t) dt = \frac{2}{T} \left[ t_{x_a} - t_{xy_a} - \frac{(x_a - y_a)}{\alpha_a} + y_a \left( \frac{T}{2} - t_{x_a} + t_{xy_a} \right) \right]$$

For Area B, Phase I:

$$P_B(I) = \frac{2}{T} \int_0^{T/2} f_b(t) dt = \frac{2}{T} \left[ t_{x_b} - \frac{y_b}{\beta_b} + y_b \left( \frac{T}{2} - t_{y_b} \right) \right]$$

For Area B, Phase II:

$$P_B(II) = \frac{2}{T} \int_{T/2}^T f_b(t) dt = \frac{2}{T} \left[ t_{x_b} - t_{xy_b} - \frac{(x_b - y_b)}{\alpha_b} + x_b \left( \frac{T}{2} - t_{x_b} + t_{xy_b} \right) \right]$$

These results are then used to compute the number of individuals deterred, discussed in Section C.

### 3. Arrest Concept

Another feature of the enforcement routine is the arrest concept. The computation of arrest rate is based on a fixed queue length model which turns away (does not arrest) all customers (drinking drivers) who arrive when the queue length is at its maximum (all task force units are making an arrest). The assumptions for this model are that drinking drivers could be apprehended by the task force at a rate of  $\lambda$ , if the task force was merely observing, rather than apprehending. This rate is assumed to be the same in Areas A and B. It is also assumed to be considerably less than the actual numbers of drinking drivers and thus no program effects are considered to be so great as to reduce the task force's ability to obtain arrests. We assume that there are  $h$  task force units and each unit holds only one driver for booking. Thus a queue length for booking is only  $h$  individuals and officers are occupied until the individual is booked. The booking is central and only one driver may be booked at a time. The "service rate" or booking capability is  $\mu$  drivers per hour. After the driver is admitted, the task force may arrest another driver (the queue is not busy).

For these assumptions and assuming Poisson drinking driver observation rate and exponential service, the arrest rate  $\lambda_{AR}$  (weekly) can be shown to be:

$$\lambda_{AR} = \lambda \left[ 1 - \frac{\left(\frac{\lambda}{\mu}\right)^h \left(1 - \frac{\lambda}{\mu}\right)}{1 - \left(\frac{\lambda}{\mu}\right)^{h+1}} \right]$$

and the number arrested during each phase,

$$N_{AR} = \lambda_{AR} \left(\frac{T}{2}\right) w$$

where  $w$  is the hours/work week/task force unit and  $T/2$  is the number of weeks of operation for each phase. The task force hours for each phase are given by

$$W = \frac{whT}{2}$$

and the costs are

$$C = cW$$

where  $c$  is the hourly cost of a task force unit in operation.

#### 4. Computation of Crashes

Using the deterrence model we have  $P_A(I)$ ,  $P_A(II)$ ,  $P_B(I)$ ,  $P_B(II)$ , the time-average proportion of deterred drivers for each area and each phase. Multiplying this by the proportion of drivers who drink in each area,  $d_A$  and  $d_B$ , yields the average proportion of the driving population in each deterred drinker group. Further multiplication by the number of licensed drivers,  $L_A$  and  $L_B$ , yields the average number of deterred drivers.

Using the arrest model, the average number of drivers in the task force arrest category is  $N_{AR}/2$  where  $N_{AR}$  is the number of arrests in a phase.

Table 1 shows the number of drivers by category and by phase.

Finally, for each category the number of drivers is multiplied by the crash rate per driver in that category. The crash rate is input by year, so a factor is included to yield the number of crashes for the relevant time period (Phase I = Phase II = Control) in each category, Phase I vs. Phase II vs. Control.

Table 1

AVERAGE NUMBER OF DRIVERS IN A CATEGORY BY PHASE

Area:	Phase I		Phase II		Control	
	A	B	A	B	A	B
Non-drinkers	$L_A(1-d_A)$	$L_B(1-d_B)$	$L_A(1-d_A)$	$L_B(1-d_B)$	$L_A(1-d_A)$	$L_B(1-d_B)$
Deterred Drinkers	$L_A d_A P_A(I)$	$L_B d_B P_B(I)$	$L_A d_A P_A(II)$	$L_B d_B P_B(II)$	0	0
Task Force Arrest	$N_{AR}/2$	0	0	$N_{AR}/2$	0	0
No Task Force Arrest	$L_A d_A (1-P_A(I)) - \frac{N_{AR}}{2}$	$L_B d_B (1-P_B(I))$	$L_A d_A (1-P_A(II))$	$L_B d_B (1-P_B(II)) - \frac{N_{AR}}{2}$	$L_A d_A$	$L_B d_B$

## 5. Cost Effectiveness

For arrest, a cost of task force operation was computed. Next, the number of crashes in each area, each phase, is summed and a societal cost of a crash (input) is applied to determine the cost of crashes in each area, in each phase. The cost savings of reduced crashes are determined by subtracting the Phase I, Area A crash cost and task force cost from the Area A control. The computation for Phase II, Area B is the same. For Phase II, Area A and Phase I, Area B, there are no task force costs, but differences in crash costs are computed. Total savings for the task force activity are then computed.

### B. Modeling Demonstration Projects

The model assumes that individuals enter stage 1 at a parameterized rate. The process is assumed to be in steady state, admitting individuals to treatment for a period equivalent to the project operational time. The process branches out of stages and individuals encounter delays as they flow through the system of stages and are collected in exit stages for tracking. Each stage operates as an entity, independent of other stages, responding to the incoming flow in various ways. From the standpoint of an individual flowing through the system, the functional relationships involve stage linkages and time is calculated through these linkages. A project's counter-measure sequence of stages shares a common as well as an individual accounting of costs, workloads, and time.

#### 1. Flow Calculations

The computation of number of individuals in each stage at any time, number of individuals passing through each stage at any time, and delays for an individual are computed simultaneously. The number of individuals delayed in stage  $i$  at any time,  $L_i$ , is just

$$L_i = \lambda_i D_i$$

where  $\lambda_1$  is the flow rate of individuals into the stage and  $D_1$  is the delay time associated with the stage. The number of individuals who have passed through each stage by time  $T$  (project operational time) is calculated in sequence according to possible flow paths, starting with stage number 1. The number of individuals who have passed through stage 1 by time  $T$ ,  $N_1(T)$ , is given by:

$$N_1(T) = \lambda_1 T - \lambda_1 D_1,$$

i.e., the number that entered stage 1 during  $T$  minus the number who are delayed there. The program proceeds to the stage or stages following stage 1. For illustration, suppose that stages 2 and 3 follow stage 1 with appropriate branching probabilities  $p_{1,2}$  and  $p_{1,3}$ , where  $p_{ij}$  is the probability of going from stage  $i$  to stage  $j$ . Then the program computes the number of people delayed in stages 2 and 3 respectively, as:

$$L_2 = \lambda_1 p_{1,2} D_2 = \lambda_2 D_2$$

$$L_3 = \lambda_1 p_{1,3} D_3 = \lambda_3 D_3$$

The number of individuals,  $N_i(T)$ , who have passed through stages  $i=2$  and 3 are then computed as:

$$N_2(T) = N_1(T) p_{1,2}^{-L_2}$$

$$N_3(T) = N_1(T) p_{1,3}^{-L_3}$$

These computations are repeated for the stages which follow stages 2 and 3, and so on until all the stages are accounted for.

The process ends in a number of exit stages. Every stage except exit stages has branching probabilities  $p_{ij}$  out of the stage. Individuals in intermediate stages who do not reach an exit stage by the completion of the project operational time are counted as "trapped" since they cannot fully complete treatment. For individuals entering exit recidivism stages prior

to this time, tracking is begun immediately and is completed after a specified period, called the tracking time.

## 2. Countermeasure Stage Types

The countermeasure stages described below can be selected for use in the model, representing group allocations for treatment, actual treatment, and evaluation of treatment. These stages are highly specialized, as they were developed from specific test projects. The stages currently in use are shown on Figure 2. However, the model is quite general in that new stage types may be added, if desired. For each stage, the following is computed:

1. Number of individuals who have completed the stage
2. Cost of processing these individuals through the stage
3. Workload required to process these individuals
4. Time spent by an individual in a stage
5. Number of individuals waiting to complete a stage.

The following variables are used in computations for one or more stage types. The subscript  $x$  for each variable denotes the type of stage in which the variable is used:

### Definitions

$C_x(T)$	= Cost accrued in Stage Type $x$ by time $T$ .
$D_x$	= Delay per individual in Stage Type $x$ .
$L_x$	= Number of individuals in Stage Type $x$ at any time.
$N_x(T)$	= Number of individuals who have completed Stage Type $x$ by time $T$ .
$W_x(T)$	= Work accrued in Stage Type $x$ by time $T$ .
$at_x$	= Actual time spent by an individual in treatment or processing in Stage Type $x$ .
$av_x$	= Worker availability in Stage Type $x$ .
$c_x$	= Cost rate for one worker in Stage Type $x$ .

Type	Description	Type	Description	Type	Description
A	Multiserver queue with service	J	Pass through	S	Recidivism exit after treatment
B		K	Delay/Treatment	T	
C		L	Several K-type treatments combined	U	
D	Multiserver queue without service	M	Intermittent Treatment	V	Recidivism exit during treatment
E	Batch queue	N	Several M-type treatments combined	W	
F		O		X	
G	Several D or E-type queues combined	P		Y	
H	Several A-type queues combined	Q		Z	Exit only
I		R			

Figure 2 DEMON STAGE TYPES

- $f_x$  = Fees paid by an individual in Stage Type x.  
 $g_x$  = Number of individuals in a group, sharing treatment in Stage Type x.  
 $it_x$  = Time interval between possible assignment of groups in Stage Type x.  
 $k_x$  = Number of workers in Stage Type x.  
 $\lambda_x$  = Poisson arrival rate at Stage Type x.  
 $lt_x$  = Length of time required for completion of treatment or processing of an individual in Stage Type x.  
 $py_{xn}(t)$  = Probability of n y-type offenses in Stage Type x during time t, without considering treatment.  
 $qy_{xn}(u)$  = Probability of n y-type offenses in Stage Type x during time u, during treatment.  
 $ry_{xn}(w)$  = Probability of n y-type offenses in Stage Type x during time w, after treatment.  
 $ty_x$  = Input time for  $py_{xn}$   
 $uy_x$  = Input time for  $qy_{xn}$   
 $wy_x$  = Input time for  $ry_{xn}$   
 $w_x$  = Workload or number of groups one worker can lead simultaneously in the next stage to meet queues for Stage Type x.

Next each stage type is discussed in detail.

a. Stage Type A (Multi-server Queue with Service)

Type A represents a general queuing stage with multiple (or single) servers (workers). Several workers are available to process individuals, one at a time. Each worker has a common exponential service rate. Individuals queue until they can be processed by a worker.

The variables required for computation are as follows:

$at_a$  = Actual time spent by an individual in treatment or processing in Stage Type A (= expected service time = 1/service rate).

$av_a$  = Worker availability in Stage Type A (portion of a worker's time devoted to stage's effort).

$k_a$  = Number of workers in Stage Type A.

$c_a$  = Cost rate for one worker in Stage Type A.

For a Poisson arrival rate at a Stage Type A of  $\lambda_a$ , the expected delay in queue,  $Q_a$ , is:

$$Q_a = \frac{\frac{av_a}{at_a} p_0 \left( \lambda_a \frac{at_a}{av_a} \right)^{k_a}}{(k_a - 1)! \left( \frac{k_a \cdot av_a}{at_a} - \lambda_a \right)^2}$$

where

$$p_0 = \left[ \sum_{n=0}^{k_a-1} \frac{1}{n!} \left( \lambda_a \frac{at_a}{av_a} \right)^n + \frac{\frac{k_a \cdot av_a}{at_a} \left( \lambda_a \frac{at_a}{av_a} \right)^{k_a}}{k_a! \left( \frac{k_a \cdot av_a}{at_a} - \lambda_a \right)} \right]^{-1}$$

and the expected time spent in the stage or total delay,  $D_a$ , is the expected delay in queue plus the expected time in service,

$$D_a = Q_a + at_a.$$

The expected number of individuals in a Stage Type A at any time is  $L_a$ , where

$$L_a = \lambda_a D_a.$$

These equations are common in queuing theory applications.

Let  $M_a(T)$  be the number of individuals who entered Stage Type A during time  $T$ , the project operational time. Then,  $N_a(T)$ , the number of individuals who passed through and completed the Stage Type A in time  $T$ , is just

$$N_a(T) = M_a(T) - L_a.$$

This becomes the "M" value for the next stage. If the Stage Type A is the first stage, then  $M_a(T) = \lambda T$  where  $\lambda$  is the Poisson arrival rate at stage 1. If the Stage Type A is the last stage before an exit stage which computes recidivism,  $N_a(T)$  is the number of individuals who have completed a treatment sequence and may be tracked for purposes of program evaluation.

The work accrued in time T in the Stage Type A,  $W_a(T)$ , is computed as

$$W_a(T) = N_a(T) \text{ at}_a$$

and the cost accrued,  $C_a(T)$ , is

$$C_a(T) = W_a(T) c_a.$$

The quantities  $D_a$ ,  $L_a$ ,  $N_a(T)$ ,  $C_a(T)$  computed for Stage Type A have similar quantities computed for all stage types.

Stage Type A can have a queue overload, when  $\lambda_a > \frac{k_a \cdot av_a}{at_a}$ .

DEMON stops computation at this point and provides a queue overload message, allowing the user to change the flow to the stage, number of workers, worker availability or service time so that

$$\lambda_a < \frac{k_a \cdot av_a}{at_a}.$$

The user is cautioned that a change in flow will reduce the flow in all other stages, including stage 1, so as to maintain the ratio of branching probabilities. If the input flow for stage 1 is desired to be maintained, one option is to reduce the branching probability to the overloaded stage. This, of course, increases the number flowing to other stages and could result in new overloads.

b. Stage Type D (Multi-server Queue Without Service)

This stage type has the same properties as the Stage Type A except that the service time is not accounted for in this stage, i.e.,  $D_d = Q_d$ .

All other equations are the same. The stage following this one must be a treatment stage (K-N) which has an  $a_d$  value equal to that used for the D-type. The purpose for this stage is to allow an individual to queue until a worker has the time available for treatment, but to spread actual treatment sparsely over an extended period of time in the next stage. The notion is that the worker would not accept an individual in a treatment program unless he can see the total time for treatment ahead.

c. Stage Type E (Batch Queue Without Service)

Type E is a batch queue stage which might be useful if individuals are accepted for treatment in batches, and if waiting time is significant. In this case, one worker must have several individuals (a batch) in order to begin processing. This is a queue only stage and no service or treatment times are counted. This type of stage is, then, naturally followed by a treatment stage.

This queue is not derived from exponential service time as are Stage Types A and D, but takes several variables into account and computes an approximate (fixed) time delay. The variables are:

- $it_e$  = Time interval between possible assignment of groups in Stage Type E (if  $it_e$  = one week, then workers meet weekly to decide if a new group can be assembled).
- $lt_e$  = Length of time required for completion of treatment on processing in the next stage.
- $g_e$  = Number of individuals in a group sharing treatment or processing in the next stage.
- $k_e$  = Number of workers in the next stage to meet queues for Stage Type E.
- $w_e$  = Workload or number of groups one worker can lead simultaneously in the next stage to meet queues for Stage Type E.

Notice that there are no wage or other cost data for this type of stage since it is merely a queuing function.

The computation proceeds as follows. A maximum of

$$\frac{k_e w_e g_e}{l t_e / i t_e}$$

individuals could start each time of assignment (each  $i t_e$ ). So if

$$\lambda_e i t_e > \frac{k_e w_e g_e}{l t_e / i t_e}$$

the work force is not sufficient to handle the arrivals and DEMON stops computing and gives a queue overload. This can be overcome by changes in the parameters so that

$$\lambda_e i t_e < k_e w_e g_e.$$

If the user elects to decrease the flow,  $\lambda_e$ , or reallocate branching probabilities the same reservations are expressed as for Stage Type A--all system flows become altered.

Next, whether more or less than one group is likely to arrive during the assignment period,  $i t_e$ , is determined. Let  $I$  be the number of assignment intervals required to assemble a group. Then select a positive integer  $I$  such that

$$I \lambda_e i t_e \geq g_e > (I-1) \lambda_e i t_e.$$

Let  $J$  be the number of complete groups expected to arrive during an assignment interval. Select a positive integer  $J$  such that

$$(J+1) g_e > I \lambda_e i t_e \geq J g_e.$$

If  $I > 1$  then  $J=1$  and if  $I=1$ ,  $J > 1$ .

At the end of the  $I$ th  $it_e$  interval,  $J$  groups of size  $g_e$  can be assigned. If  $r$  individuals remain from the time when the last assignment was made, then roughly  $J g_e$  individuals arrived between  $\frac{r}{\lambda_e it_e}$  time units before the last assignment and  $\frac{J g_e - r}{\lambda_e it_e}$  time units after the last assignment.  $J g_e$  individuals are assumed to be assigned. The average waiting time for these individuals to be assigned is then

$$\frac{\left( I it_e + \frac{r}{\lambda_e} \right) + \left( I it_e - \frac{J g_e - r}{\lambda_e} \right)}{2} + \frac{1}{2} it_e ,$$

where the first term is the time between arrival and acceptance for assignment, and the second term is the time from acceptance to the first group meeting. If it is assumed that the average  $r$  is  $g_e/2$ , then

$$D_e = I it_e - \frac{(J - 1) g_e}{2 \lambda_e} + \frac{1}{2} it_e .$$

Also,

$$L_e = \lambda_e D_e$$

$$N_e(T) = M_e(T) - L_e$$

$$W_e(T) = 0$$

$$C_e(T) = 0$$

The variables  $it$ ,  $g$ , and  $k$  must have the same values in this stage as for the following stage, where treatment is actually rendered.

d. Stage Type G (Combined Queues Without Service)

Type G is a special stage type which applies to a queue for treatment when it is required that individuals complete two or more simultaneous queues, of types D or E, to enter a multiple treatment stage. Elsewhere in the model flow, the D and E types must appear separately if used unless a dummy stage D or E is declared (See m below for Dummy Stages). The Stage Types L and N, described below, are combined treatment Stage Types to one of which a Stage Type G must always flow.

The only input variables for a Stage Type G are the stage numbers for singular queues. This designation will direct the model to the appropriate stages.

For n composites, the workloads, costs and delays for a G stage are computed as follows:

$$D_g = \max (D_{g_1}, D_{g_2}, \dots, D_{g_n})$$

$$L_g = \max (L_{g_1}, L_{g_2}, \dots, L_{g_n})$$

$$N_g(T) = M_g(T) - L_g$$

$$W_g(T) = 0$$

$$C_g(T) = 0$$

No changes of parameters for the G Stage may be made independent of those for the corresponding D or E stages. A change in a D or E stage automatically changes the G stage.

For the same flow, a Stage Type G will overload if any of the components overload. While the actual component stages share parameters with the G, a G may overload without the others overloading or vice versa. This is because the actual flow of the G Stage depends on the branching probabilities, thus G may have a different input flow. Parameter changes to accommodate the overload stage (D, E or G) will be made in the other stage(s) which did not overload. If this dependence is not desired, a dummy stage should be used.

e. Stage Type H (Combined Queues with Service)

This stage operates in a manner similar to Stage Type G, except that it is a combination of any number (say, n) of A queues in the flow or A dummies, rather than D and E. The inclusion of treatment in this stage is shown by the equations:

$$D_h = \max (D_{h_1}, D_{h_2}, \dots, D_{h_n})$$

$$L_h = \max (L_{h_1}, L_{h_2}, \dots, L_{h_n})$$

$$N_h(T) = M_h(T) - L_n$$

$$W_h(T) = N_h(T) [at_{h_1} + at_{h_2} + \dots + at_{h_n}]$$

$$C_h(T) = N_h(T) [at_{h_1} C_{h_1} + at_{h_2} C_{h_2} + \dots + at_{h_n} C_{h_n}]$$

f. Stage Type J (Pass-Through)

Type J is a pass-through stage with no time delays and with no costs or work expended. It is primarily used as a branch only stage for delineation of the population totally out of control of the project. No data are input.

The computations are as follows:

$$D_n = 0$$

$$L_n = 0$$

$$N_n(T) = M_n(T)$$

$$W_n(T) = 0$$

$$C_n(T) = 0$$

g. Stage Type K (Fixed Time Delay With Holding)

Type K represents any process which takes place with a fixed time delay; i.e., an individual remains in the stage for a constant length of time, independent of the number of individuals or the number of workers.

The variables required for computation are as follows:

$at_k$  = Actual time spent by an individual in treatment or processing in Stage Type K

$lt_k$  = Length of time required for completion of treatment or processing of an individual in Stage Type K

$g_k$  = Number of individuals in a group, sharing treatment in Stage Type K

$c_k$  = Cost rate for one worker in Stage Type K

$f_k$  = Fees paid by an individual in Stage Type K.

In this stage, it is assumed that an individual is delayed by  $lt_k$ , regardless of queue problems, worker availability, etc., and that at some time during  $lt_k$  he receives the worker's attention for a time  $at_k$ , attention which is shared among  $g_k$  individuals.

The computations for this stage are straightforward:

$$D_k = 1t_k$$

$$L_k = \lambda_k D_k$$

$$N_k(T) = M_k(T) - L_k$$

$$W_k(T) = N_k(T) \left( \frac{at_k}{g_k} \right)$$

$$C_k(T) = N_k(T) \left[ c_k \frac{at_k}{g_k} - f_k \right]$$

If individuals receive treatment alone, set  $g_k=1$ . If groups are to be considered, and general queuing or waiting for a group to be assembled may be a problem, the user may precede this stage by a Stage Type E, batch queue.

h. Stage Type L (Simultaneous Fixed Time Delays With Holding)

Type L can be used in conjunction with a Stage Type G or it can be used alone. The L stage represents two or more simultaneous K type treatment stages.

The input data for a Stage Type L are the stage numbers of the n K stages. Computations are made as follows:

$$D_l = \max (D_{l_1}, D_{l_2}, \dots, D_{l_n})$$

$$L_l = \max (L_{l_1}, L_{l_2}, \dots, L_{l_n})$$

$$N_l(T) = M_l(T) - L_l$$

$$W_l(T) = N_l(T) \left( \frac{at_{l_1}}{g_{l_1}} + \frac{at_{l_2}}{g_{l_2}} + \dots + \frac{at_{l_n}}{g_{l_n}} \right)$$

$$C_l(T) = N_l(T) \left[ c_{l_1} \left( \frac{at_{l_1}}{g_{l_1}} \right) + c_{l_2} \left( \frac{at_{l_2}}{g_{l_2}} \right) + \dots + c_{l_n} \left( \frac{at_{l_n}}{g_{l_n}} \right) - f_{l_1} - f_{l_2} - \dots - f_{l_n} \right]$$

Changes in the L stage are made only through the G stages and changing a non-dummy G stage makes the identical change to the L.

1. Stage Type M (Fixed Time Delay Without Holding)

Type M is a stage with zero residence time for the individual but costs and workloads are accrued. It is used only to represent treatment in cases where the subject is considered to be capable of repeating while undergoing treatment. Treatment is for a fixed time period. Generally, the individual passes on to an exit recidivism stage while still being treated by the workers in the Stage Type M.

The variables required for computation are as follows:

$lt_m$  = Length of time required for completion of treatment or processing of an individual in Stage Type M.

$at_m$  = Actual time spent by an individual in treatment or processing in Stage Type M.

$c_m$  = Cost rate for one worker in Stage Type M.

$g_m$  = Number of individuals in a group, sharing treatment in Stage Type M.

$f_m$  = Fees paid by an individual in Stage Type M.

The reader will notice that the input data are identical to that for a Stage Type K, but the computations are different:

$$D_m = 0$$

$$L_m = 0$$

$$N_m(T) = M_m(T)$$

$$W_m(T) = N_m(T) \left( \frac{at_m}{g_m} \right)$$

$$C_m(T) = N_m(T) \left[ c_m \left( \frac{at_m}{g_m} \right) - f_m \right].$$

Group treatment is also used as in K.

One useful application of a Stage Type M is for a type of treatment where the individual has been assigned to a program for an extended period of time but only meets with the worker a few times during the time period. The Stage Type M counts the actual time spent with the worker while the individual is free to repeat a violation in the next stage. The time that the individual is in treatment is considered in recidivism behavior. This compares to a Stage Type K where an individual may not repeat during treatment.

j. Stage Type N (Simultaneous Fixed Time Delays Without Holding)

Type N can be used in conjunction with a Stage Type G or it can be used alone. The N stage represents two or more simultaneous M type treatment stages.

The input data for a Stage Type N are the stage numbers of the n M stages. Computations are made as follows:

$$D_n = 0$$

$$L_n = 0$$

$$N_n(T) = M_n(T) \left[ \frac{at_{n_1}}{g_{n_1}} + \frac{at_{n_2}}{g_{n_2}} + \dots + \frac{at_{n_n}}{g_{n_n}} \right]$$

$$W_n(T) = N_n(T) \left[ \frac{at_{n_1}}{g_{n_1}} + \frac{at_{n_2}}{g_{n_2}} + \dots + \frac{at_{n_n}}{g_{n_n}} \right]$$

$$C_n(T) = N_n(T) \left[ c_{n_1} \frac{at_{n_1}}{g_{n_1}} + c_{n_2} \frac{at_{n_2}}{g_{n_2}} + \dots + c_{n_n} \frac{at_{n_n}}{g_{n_n}} - f_{n_1} - f_{n_2} - \dots - f_{n_n} \right]$$

Changes in the N stages are made only through the M stages and changing a non-dummy M stage makes the identical change to the M.

k. Stage Types S and V (Recidivism)

Types S and V are recidivism stages, final stages through which an individual flows no further. Every allocation/treatment or control group enters this type of stage or another exit stage, Type Z. The difference between a type S and a type V is that the type V allows recidivism during treatment; S does not.

Two measures of program impact can be analyzed within the DEMON structure: the number of future offenses and test score improvement. The number of future offenses is assumed to be a function of the time since treatment, while pre- and post-treatment test score differences are not a function of time. The offense recidivism function assumes an increasing probability of committing an observed offense as the time since an individual underwent treatment increases. The measurement of any test score improvement is done by comparing the results of a test that is administered before and after treatment.

In DEMON, three types of offense recidivism and one type of test score improvement may be modeled simultaneously and analyzed separately. It is emphasized that the recidivism probabilities and test score changes are assumed known based on the expected impact of the project under analysis. These data can be treated as parameters, and sensitivity studies on how the program impact varies as the parameters are arranged can be accomplished readily by DEMON.

o Offense Recidivism

It is assumed that the time between successive violations are distributed exponentially,  $f_i(x) = \eta_1 e^{-\eta_1 x}$ , where  $f_i(x)$  is the density function for the time between the  $(i - 1)$ st and the  $i$ th offense. Thus, we have the mean parameter  $\frac{1}{\eta_1}$ , for the time to the first violation,  $\frac{1}{\eta_2}$ , for the time from the first to the second violation, etc. For this assumption, the probabilities  $p_n(t)$ ,  $n = 0, 1, 2, \dots$  are the probabilities of having  $n$  offenses in time  $t$ . We examine the probabilities of 0, 1, 2, 3, 4, 5 or more offenses in time  $t$  for the model:

$$p_0(t) = \int f(x_1) dx_1$$

$$\{ x_1 \geq t \}$$

$$p_1(t) = \int f(x_1) f(x_2) dx_1 dx_2$$

$$\{ x_2 \geq t - x_1, \\ x_1 \leq t \}$$

$$p_2(t) = \int f(x_1) f(x_2) f(x_3) dx_1 dx_2 dx_3$$

$$\{ x_3 \geq t - x_1 - x_2, \\ x_2 \leq t - x_1, \\ x_1 \leq t \}$$

$$p_3(t) = \int f(x_1) f(x_2) f(x_3) f(x_4) dx_1 dx_2 dx_3 dx_4$$

$$\{ x_4 \geq t - x_1 - x_2 - x_3, \\ x_3 \leq t - x_1 - x_2, \\ x_2 \leq t - x_1, \\ x_1 \leq t \}$$

$$p_4(t) = \int f(x_1) f(x_2) f(x_3) f(x_4) f(x_5) dx_1 dx_2 dx_3 dx_4$$

$$\{ x_5 \geq t - x_1 - x_2 - x_3 - x_4, \\ x_4 \leq t - x_1 - x_2 - x_3, \\ x_3 \leq t - x_1 - x_2, \\ x_2 \leq t - x_1, \\ x_1 \leq t \}$$

$$p_5(t) = 1 - p_0(t) - p_1(t) - p_2(t) - p_3(t) - p_4(t).$$

For a type V, two sets of parameters may be used for a type of offense studied, one set of recidivism probabilities while still under a program, and another set after completion of the program. In this situation we let

$p_n(t)$  = probability of  $n$  violations by time  $t$ , considering treatment

$q_n(t)$  = probability of  $n$  violations during treatment by time  $t$ ,  $t \leq t_1$

$r_n(t)$  = probability of  $n$  violations after treatment by time  $t$ ,  $t > t_1$ ,

where  $t_1$  is the length of treatment and  $q$  and  $r$  follow the same distribution as  $p$ . Below,  $p$  is derived using  $q$  and  $r$ .

By properties of the exponential distribution, we have

$$p_0(t) = \begin{cases} q_0(t) & , t \leq t_1 \\ q_0(t_1) r_0(t-t_1) & , t > t_1 \end{cases}$$

$$p_1(t) = \begin{cases} q_1(t) & , t \leq t_1 \\ q_0(t_1) r_1(t-t_1) + q_1(t_1) r_0(t-t_1) & , t > t_1 \end{cases}$$

$$p_2(t) = \begin{cases} q_2(t) & , t \leq t_1 \\ q_0(t_1) r_2(t-t_1) + q_1(t_1) r_1(t-t_1) + q_2(t_1) r_0(t-t_1) & , t > t_1 \end{cases}$$

or, in general we have

$$p_n(t) = \begin{cases} q_n(t) & , t \leq t_1 \\ \sum_{i=0}^n q_i(t_1) r_{n-i}(t-t_1) & , t > t_1 \end{cases}$$

for  $n = 0, 1, 2, 3, 4$ , and

$$p_5(t) = \begin{cases} 1 - \sum_{i=0}^4 q_i(t) & , t \leq t_1 \\ 1 - \sum_{i=0}^4 p_i(t) & , t > t_1 \end{cases}$$

For a Stage Type S (no recidivism during treatment), the data input for offense type  $y$  are a time,  $ty_s$  and a set of probabilities  $\{py_{sn}(ty_s), n=0, \dots, 4\}$ . Then  $py_{sn}(ty_s)$  is computed. For a Stage Type V (recidivism possible while in treatment), the data for offense type  $y$  is a time  $uy_v$ , a set  $\{qy_{vn}(uy_v), n=0, \dots, 4\}$ , a time,  $wy_v$ , and a set  $\{ry_{vn}(wy_v), n=0, \dots, 4\}$ , and the whole set  $\{py_{vn}(uy_v + wy_v), n=0, \dots, 4\}$  is computed.

#### • Probability Conversion

While the input probabilities must correspond to the input times, they need not reflect the actual treatment or tracking time. The user may input probability data for whatever time interval is used by the data source. The recidivism routines in DEMON will convert to actual treatment and tracking times for output.

Given an input time and input probabilities, first DEMON converts the input data to exponential parameters. For a Stage Type S, the time  $t$  and probabilities  $\{py_{sn}(t)\}$  are converted to the exponential parameters  $\eta_1, \eta_2$ , etc. For a Stage Type V, the time  $u$  and probabilities  $\{qy_{vn}(u)\}$  are converted to during treatment parameters and time  $w$  and probabilities  $\{ry_{vn}(w)\}$  are converted to after treatment parameters. Now, the input data have been converted to time-independent parameters. These parameters may then be used to compute equations for  $\{py_{vn}(t)\}$ , as shown above, for any  $t$ .

As the actual solution for the integrals is lengthy and the conversion routine is complicated, a simplifying assumption was made on the parameters; i.e., the parameters for the second and further offenses for a given type of violation are the same,

$$\eta_1 = \eta_1; \eta_n = \eta_2, n \geq 2.$$

With this simplifying assumption for offense recidivism, only the first two probabilities are required to solve for the exponential parameters. Only the probability equations need be replaced in DEMON if another recidivism submodel would ever be desired.

#### • Test Score Improvements

An optional input is to allow the recidivism routines to make calculations of test score improvement. The input are probabilities of improvement in tests taken before and after treatment. The categories are:

- (1) More than 25% better;
- (2) 20% to 25% better;
- (3) 15% to 20% better;

- (4) 10% to 20% better;
- (5) 5% to 10% better; and,
- (6) No improvement.

These inputs correspond to  $p_0(t)$ ,  $p_1(t)$ ,  $p_2(t)$ ,  $p_3(t)$ ,  $p_4(t)$  and  $p_5(t)$  respectively for the offense recidivism. The individuals taking these tests are presumed to be placed into one of the six categories in each exit stage. No calculations using the exponential distribution are made, as no time factor is included. The input probabilities are used directly for final calculations.

• Number of Recidivists

Each data file has up to four types of recidivism categories--DWI Arrests, Crashes, Violations or Test Score Improvements. Probabilities for each correspond to a common time. If a type is not used in a data file, this type may not be studied with that data file. The probabilities of recidivating during the tracking time are computed by DEMON or, in the case of test scores, taken directly, and are multiplied by the number of individuals who entered the exit stage during the project operational time. These give the number of individuals who had 0, 1, 2, 3, 4, 5 or more repeat offenses. These calculations are used for statistical testing.

o Project Accounting

For a Stage Type S the individual is delayed for the project tracking time, S. In this stage all who have completed treatment or control stages enter the exit stage and are finally "captured" as  $N_s(T)$ . The computations are as follows:

$$D_s = S \text{ (tracking time)}$$

$$L_s = 0$$

$$N_s(T) = M_s(T)$$

$$W_s(T) = N_s(T) [at_s]$$

$$C_s(T) = W_s(T)c_s$$

The calculations for a Stage Type V are exactly the same.

1. Stage Type Z (Dropout Exit)

Type Z is a stage representing an exit from the system under study. This is used to represent individuals who violate the rules, are diverted from or do not qualify for a particular type of treatment and are not tracked. There are no delays, work or costs associated with this stage; it simply counts individuals. The computations are as follows:

$$D_h = 0$$

$$L_h = 0$$

$$N_h(T) = M_h(T)$$

$$W_h(T) = 0$$

$$C_h(T) = 0$$

The costs and work required for treatment of these individuals are counted in previous stages; costs and work in the previous stages are counted as if the individual completed treatment.

Interactive changes are made as for a Stage Type S and both sets of time-dependent probabilities may be changed, independent of one another. After the computations resulting in one set of probabilities the  $D_v$ ,  $L_v$ ,  $N_v(t)$ ,  $W_v(T)$  and  $C_v(T)$  computations are the same as for a Stage Type S.

m. Dummy Stages

The previously mentioned combined stages--G, H, L or N have the property of only being able to be changed by changing one or all of the component stages--types D, E, A, K or M. This property is useful for demonstration projects because of balancing treatments. Occasionally one wishes to add a treatment, combined with others which is not represented elsewhere in the flow. This is accomplished by declaring a dummy stage which can be a D, E, A, K or M and is denoted by a stage number greater than 80. A dummy stage is not in the flow but is called by a combined stage, which is in the flow.

Another use is to allow an experiment to be designed to be unbalanced, unbalanced in the sense of having a stage in a combined modality that has the same structure as one represented elsewhere alone, but can be changed within the combined modality, independent of its separate counterpart. An extra dummy stage may be kept separate if one wishes to introduce this variation.

### 3. Stage Linkage

Summarizing the above stage descriptions, certain linkage rules are given as follows:

- Stage Sequence--Exit stages cannot be followed by other stages; treatment and queuing stages must be followed by other stages. Permissible order is given below
  - Stage Types A, H, J, K, L - may be followed by any stage other than Stage Type V
  - Stage Types D, E, G - may only be followed by Stage Types K, L, M or N
  - Stage Types M, N - may only be followed by Stage Types V or Z
  - Stage Types S, V, Z - may not be followed.

A data file which violates one of these requirements will not be accepted by DEMON.

- o Treatment Time--The treatment time variable,  $at_x$ , in queues without service (Stage Types D or E) should have an input value which coincides with that of the treatment time variable in the next stage. The treatment time variable for M or N stages will be used for calculations of during treatment recidivism in the next stage, if the next stage is a recidivism Stage Type S.
- o Combined Stages--Stage Types G, H, L and N are combined stages and take variable values from other stages.

Other model features which involve stage linkage are described below.

- **System Flows**--In the model, every stage has flow into it. Of particular importance is the system flow to stage number 1, the flow to the total system. This is the only data file flow input. Flow to all other stages are computed based on this initial flow and input branching ratios. A change in flow to one stage will affect others, and changes in flow to all stages are made immediately upon change of one stage and according to the branching ratios allocated. For any stage changed, then, the flow will be increased or decreased in other stages to maintain the ratios.
- **Branching Ratios**--All stages except exit Stage Types S, V and Z have branching ratios, i.e., probabilities of transfer to succeeding stages. Two or more stages may not branch to the same stage and branching is from a lower numbered stage to a higher one. For a data file already made, new branches may not be added but probabilities may be changed. A branch may be eliminated by assigning a probability value of zero. If the user wishes to add or delete a stage, it is best to make a new data file. If input branching probabilities do not sum to one, the program normalizes input accordingly, so that resultant probabilities of branching out of a stage sum to one.
- **Groupings**--Data files may be prepared which use the grouping feature of the model. Using this feature, the system flows are partitioned into various groups. Each group has its own flow that sums to the total flow for that stage. Each category has its own set of branching ratios at each stage and the flow is split accordingly, but costs and types of stages are identical and workers are shared among the groups. No differences in recidivism can be identified by groups. The primary use for this feature is to assign varying probabilities of being identified, e.g., as a problem drinker or as a treatment dropout according to the demographic grouping.
- **Queues**--Every queueing stage has certain parameters which determine the speed of service and number of individuals who can be handled. If the flow rate into a queue is too large i.e., if the queue will increase indefinitely, DEMON will stop processing and indicate to the user that a parameter change is necessary.

- Target Group Generator--The user is given the option to delineate the total population of an area into a target group (e.g., DWI arrests shown on Figure 1). These delineation stages are unnumbered and precede stage 1. If the last stage in the target group generator, i.e., the stage that feeds directly into stage 1 does not indicate enough individuals to be obtained for project evaluation, DEMON will not continue. This shortage will occur if the system flow rate to stage 1 times the project operational time T is greater than the number of remaining in the population in the last stage in the target group generator.

#### 4. Input Data

Specific data items required to define a flow are listed below:

- Total population, subpopulation delineation to reach the target group, stage 1 generator.
- Time unit used for all data variables (e.g., work day, work week, work month).
- Numerical ordering of stages, stage names and Stage Type identification.
- Project operational time.
- Tracking time.
- Branching ratios, groupings and identification of succeeding stages (non-exit stages only).
- Other input by stage:

Types A & D

- 1. Actual treatment (service) time ( $at_a$  or  $at_d$ )
- 2. Number of workers ( $k_a$  or  $k_d$ )
- 3. Workers' wages ( $c_a$  or  $c_d$ )
- 4. Worker availability ( $av_a$  or  $av_d$ )

Type E

- 1. Number of individuals per group ( $g_e$ )
- 2. Number of workers ( $k_e$ )
- 3. Number of groups per worker ( $w_e$ )
- 4. Time interval between assignments ( $it_e$ )
- 5. Length of treatment ( $lt_e$ )

- |                 |         |   |
|-----------------|---------|---|
| Types K & M     | -       | 1. Actual treatment (service) time ( $at_k$ or $at_m$ )                       |
|                 |         | 2. Number of individuals per group ( $g_k$ or $g_m$ )                         |
|                 |         | 3. Workers' wages ( $c_k$ or $c_m$ )  |
|                 |         | 4. Length of treatment ( $lt_k$ or $lt_m$ )                                   |
|                 |         | 5. Fees paid per individual ( $f_k$ or $f_m$ )                                |
| Type G, H, L, N | -1. -n. | Stage numbers of n component stages   |
| Types S & V     | -1.     | Actual treatment (tracking) time<br>( $at_s$ or $at_v$ )                      |
|                 |         | 2. Workers wages ( $c_s$ or $c_v$ )   |
|                 |         | 3. Identification of types of recidivism<br>used and times and probabilities. |
| Types J & Z     | -       | No further input.   |

### C. Postprocessing Routine to Evaluate Impact

Statistical routines were added to DEMON to aid in analyzing, in a statistical sense, any project impact implied by the recidivism and test score calculations. This commonly involves a question of sample size, and for a Demonstration Project, the sample size is a major determiner of cost. The cost of processing the model derived sample size is a standard DEMON output. The question is, "Does the given project sample size meet statistical criteria--i.e., allow us to make statements of statistical significance concerning the results of the recidivism and test score computations?" More precisely, "Can a reduction in recidivism be detected when a relatively small portion of the sample can be expected to repeat violations in a typical 1-2 year tracking period?" Sample size requirements tend to be large in this type of situation.

A typical situation involves experimental and control groups. Both groups' traffic records are monitored for a fixed length of time to determine future traffic accidents, future drunk driving arrests, etc. The objective is to measure differences in future behavior with respect to each such offense, experimental versus control. Thus, for one type of offense, data might appear as follows:

<u>Number of Offenses of a Certain Type</u>	<u>Experimental</u>	<u>Control</u>
0	$X_0$	$X'_0$
1	$X_1$	$X'_1$
2	$X_2$	$X'_2$
3	$X_3$	$X'_3$
4	$X_4$	$X'_4$
5 or more	$X_5$	$X'_5$
Total	$X$	$X'$

where  $X_i$  = number of individuals in the experimental group who had  $i$  offenses of a certain type during the fixed time of traffic record monitoring and similarly,  $X'_i$  for controls.

The interest is to determine whether or not there are differences in the number of offenses which result from individuals in each group-- that is, whether the mean number of offenses in the experimental group is lower than the mean of the control group, e.g., the experimental mean is less than 80 percent of the control mean. Similarly, a test that the proportion (rather than the mean) in the no offense category is increased is of value.

In studying test scores, the test score improvement-->25%, 20-25%, 15-20%, 10-15%, 5-10%, <5%--is examined instead of 0, 1, 2, 3, 4, 5 or more offenses, testing for differences in percent improvement or for difference in maximum improvement (>25%).

1. Notation

The following definitions are made:

For Experimental Group

$X_{ij}$  = Number of individuals having  $i$  offenses of type  $j$

$M$  = Number of individuals tested

$\bar{X}_j = \frac{1}{M} \sum_{i=0}^5 i X_{ij}$  = Mean number of  $j$  type offenses\*

$\mu_j = E \bar{X}_j$  = True mean number of  $j$  type offenses (input parameter, not to be calculated)

$\bar{X}_{oj} = \frac{X_{oj}}{M}$  = Proportion of non-offenders

$\theta_j = E \bar{X}_{oj}$  = True proportion of non-offenders (input parameter, not to be calculated)

$S_j^2 = \frac{1}{M} \sum_{i=1}^5 i^2 X_{ij} - \bar{X}_j^2$  = Sample variance for the number of offenses

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\* 5 or more is assigned 5, with little anticipated loss of accuracy.

For test scores,  $X_{ij}$  is the number of individuals in each category  $i$ ,  $\bar{X}_j$  is the mean percent test score reduction and  $\bar{X}_{oj}$  is the proportion of those who had maximum improvement of  $\geq 25\%$ , for  $j$  the "test score offense." The proportion is still computed as  $X_{oj}/M$ . For this case, the mean is computed differently:

$$(.25 X_{oj} + .20 X_{1j} + .15 X_{2j} + .10 X_{3j} + .05 X_{4j} + 0 X_{5j})/M.$$

For the Control Group

$X'_{ij}$  = Number of individuals having  $i$  offenses of type  $j$

$N'$  = Maximum number of offenses

$M'$  = Number of individuals tested

$\bar{X}'_j = \frac{1}{M} \sum_{i=1}^N i X_{ij}$  = Mean number of  $j$  type offenses\*

$\mu'_j = E \bar{X}'_j$  = True mean number of  $j$  type offenses (input parameter, not to be calculated)

$\bar{X}'_{oj} = \frac{X_{oj}}{M}$  = Proportion of non-offenders

$\theta'_j = E \bar{X}'_{oj}$  = True proportion of non-offenders (input parameter, not to be calculated)

$S_j^{2'} = \frac{1}{M} \sum_{i=1}^N i^2 X_{ij} - \bar{X}'_j^2$  = Sample variance for the number of offenses

General

$\alpha$  = Test size (level of significance), i.e.,  $P \{ \text{rej } H | H \} = \alpha$

$1 - \beta$  = Test power, i.e.,  $P \{ \text{rej } H | \text{alt} \} = 1 - \beta$   
 $\beta$  will depend on the particular alternative.

$Z(W)$  = The  $W$  percentile of a standard normal, i.e.,

$$\int_{-\infty}^{Z(W)} \frac{1}{\sqrt{2\pi}} e^{-t^2/2} dt = W$$

## 2. Hypothesis Testing

In the following it is assumed that all testing, power determination, and sample sizing will be done separately for each offense type  $j$ . The primary hypotheses are

$$H_1 : \theta_j = \theta'_j \quad (\text{Proportion Hypothesis})$$

or

$$H_2 : \mu_j = \mu'_j \quad (\text{Mean Hypothesis})$$

The primary interest for demonstration projects is in one-sided tests. However, several variations of the primary hypotheses and associated alternatives may be investigated, such as

$$\theta_j < \theta'_j \text{ vs } \theta_j > \theta'_j \text{ or } \theta_j = \theta'_j \text{ vs } \theta_j \neq \theta'_j.$$

Note that for these variations of  $H_1$  (also  $H_2$ ) and alternatives, the test statistic remains the same. DEMON only prints the value of the appropriate statistic. The user can then choose a critical level, test variation, and only a simple table (Normal) look up is required.

The procedure then is to compute, for  $H_1$  type hypotheses

$$Z_1 = \frac{\bar{X}'_{oj} - \bar{X}_{oj}}{\sqrt{\frac{\bar{X}'_{oj}(1 - \bar{X}'_{oj})}{M'} + \frac{\bar{X}_{oj}(1 - \bar{X}_{oj})}{M}}}$$

and for  $H_2$  type hypotheses

$$Z_2 = \frac{\bar{X}_j - \bar{X}'_j}{\sqrt{\frac{S_j^2}{M} + \frac{S'_j{}^2}{M'}}}$$

Both  $Z_1$  and  $Z_2$  are assumed Normal for  $M, M' \geq 50$ . Note that the numerators are set up for a one-sided test to the left; i.e., negative values for both  $Z_1, Z_2$  indicate an improvement in the experimental group.

### 3. Size and Power

For discussion purposes consider the  $H_2$  type hypotheses. Suppose that an  $\alpha$  level test is required, and that it is one-sided. The samples are collected so that  $M, M', \text{ etc.}$  are known. From the preceding section

$$P \{ \text{rejecting } H_2 | H_2 \} =$$

$$P \left\{ \frac{\bar{X}_j - \bar{X}'_j}{\sqrt{\frac{S_j^2}{M} + \frac{S_j'^2}{M'}}} \leq Z(\alpha) \right\} = \alpha$$

To find the power  $1 - \beta$  for an alternative where  $\mu_j \neq \mu'_j$  and both are specified, the expression is

$$P \{ \text{rej } H_2 | \mu_j, \mu'_j, \mu_j \neq \mu'_j \} =$$

$$P \left\{ \frac{\bar{X}_j - \bar{X}'_j}{\sqrt{\frac{S_j^2}{M} + \frac{S_j'^2}{M'}}} \leq Z(\alpha) \mid \mu_j, \mu'_j, \mu_j \neq \mu'_j \right\} =$$

$$P \left\{ \frac{\bar{X}_j - \bar{X}'_j - (\mu_j - \mu'_j)}{\sqrt{\frac{S_j^2}{M} + \frac{S_j'^2}{M'}}} \leq Z(\alpha) - \frac{(\mu_j - \mu'_j)}{\sqrt{\frac{S_j^2}{M} + \frac{S_j'^2}{M'}}} \right\} =$$

$$P \left\{ Z \leq Z(\alpha) - \frac{(\mu_j - \mu'_j)}{\sqrt{\frac{S_j^2}{M} + \frac{S_j'^2}{M'}}} \right\} = 1 - \beta$$

All terms on the right of the inequality above are known, so that the probability  $1 - \beta$  can be read directly from the normal density tables. But, an assumption was made that  $S_j^2$  and  $S_j'^2$  are true variances. This assumption is routinely made for sample sizes of 30 or more, and in this case, when  $M, M' > 100$  the resulting error can be ignored.

From the above equation the relatively simple expression

$$-\frac{\mu_j - \mu_j'}{\sqrt{\frac{S_j^2}{M} + \frac{S_j'^2}{M'}}} = Z(1 - \alpha) + Z(1 - \beta)$$

is derived which is the final form required. If all terms on the left side are given and  $\alpha$  is specified, a table look up only is required (or calculation) for  $Z(1 - \alpha)$  and then the power may be computed directly.

To find the required sample size for a given power, set  $M = a M'$  (where  $a$  is the ratio of the experimental to control group size and is given by the user) in order to have an equation with only one unknown, and solve the last equation for sample size.

For  $H_1$  type hypotheses, the procedure is exactly the same, obtaining

$$-\frac{\theta_j' - \theta_j}{\sqrt{\frac{\theta_j(1-\theta_j)}{M} + \frac{\theta_j'(1-\theta_j')}{M'}}} = Z(1 - \alpha) + Z(1 - \beta)$$

The above derivations are based on a one-sided test. A two-sided test approach follows almost trivially by doubling  $\alpha$  and taking absolute values of the left sides of the two equations above.

#### 4. Statistical Tests

The user will first specify the offense type to be analyzed. Then, the hypothesis to be tested is selected, either  $H_1$  or  $H_2$ . Next, there are three questions to be answered:

1. Is the observed difference significant; i.e., what is found in a test of the selected hypothesis?
2. What is the power of the test for a specified alternative?
3. What sample size would be required to achieve a given (input specified) test power?

To meet these objectives the following routine was derived.

First the values

$$\{X_{ij}\}, M, \bar{X}_j, \bar{X}_{oj}, S_j^2 \quad (\text{experimental})$$

$$\{X'_{ij}\}, M', \bar{X}'_j, \bar{X}'_{oj}, S_j'^2 \quad (\text{control})$$

are computed and output for the users information. Next, according to whether  $H_1$  or  $H_2$  is selected,  $Z_1$  or  $Z_2$  (equations cited in B above) are provided.

#### 5. Computation of Test Power

To determine the test power for a specified alternative using hypothesis type  $H_1$ , the user specified values for

$\alpha$  - The test level

$O_j$  - (Theoretical) expected value of  $\bar{X}_{oj}$

$O'_j$  - (Theoretical) expected value of  $\bar{X}'_{oj}$

and the equation cited in C above is solved for  $1 - \beta$ , providing test power as output.

Similarly, to determine the test power for a specified alternative under a type  $H_2$ , the following five parameters must be input specified:

- $\alpha$  - The test level
- $\mu_j$  - (Theoretical) expected value of  $\bar{X}_j$
- $\sigma_j^2$  - (Theoretical) variance in the experimental group
- $\mu_j'$  - (Theoretical) expected value of  $\bar{X}_j$
- $\sigma_j'^2$  - (Theoretical) variance in the control group

and the equation cited in C above is solved to provide test power.

For example, for  $H_2$ , one-sided, to find the power  $1 - \beta$  given the following input:

$$\begin{array}{ll} \alpha = .05 & \mu_j' = 5 \\ \mu_j = 3 & \sigma_j'^2 = 50 \\ \sigma_j^2 = 50 & M' = 100 \\ M = 100 & \end{array}$$

the computation

$$-\frac{3 - 5}{\sqrt{\frac{50}{100} + \frac{50}{100}}} = Z(.95) + Z(1 - \beta)$$

$$2 = 1.65 + Z(1 - \beta)$$

$$.35 = Z(1 - \beta)$$

is made and the power determined

$$1 - \beta \approx .6368.$$

## 6. Computation of Sample Size

To determine sample size required for a specified alternative, the user will specify

- $\alpha$  - The test level
- $\theta_j$  - (Theoretical) expected value of  $\bar{X}_{oj}$
- $\theta'_j$  - (Theoretical) expected value of  $\bar{X}'_{oj}$
- $1-\beta$  - The desired test power
- a - Ratio desired, (Experimental Group Size)/(Control Group Size)

For  $H_2$  type hypotheses:

- $\alpha$  - The test level
- $\mu_j$  - (Theoretical) expected value of  $\bar{X}_j$
- $\sigma_j^2$  - (Theoretical) variance in the experimental group
- $\mu'_j$  - (Theoretical) expected value of  $\bar{X}'_j$
- $\sigma_j'^2$  - (Theoretical) variance in the control group
- $1-\beta$  - The desired test power
- a - Ratio desired, (Experimental Group Size)/(Control Group Size).

Then  $H_1$  and  $H_2$  are solved for M, and M' is then obtained by solving  $M' = aM$ . M is then the required sample size for the experimental group and M' for control to detect differences in proportions ( $H_1$ ) or means ( $H_2$ ) to the extent specified by the theoretical values input.

For example, if  $\mu_j = 3$  and  $\mu'_j = 5$  then the postulated reduction is 2 offenses per person or 40 percent. The M, M' computed would be the samples required to detect the 40 percent reduction for a given power.

1. The first part of the document discusses the importance of maintaining accurate records of all transactions and activities. It emphasizes that this is essential for ensuring transparency and accountability in the organization's operations.

2. The second part of the document outlines the various methods and tools used to collect and analyze data. It highlights the need for consistent data collection procedures and the use of advanced analytical techniques to derive meaningful insights from the data.

3. The third part of the document focuses on the role of technology in data management and analysis. It discusses how modern software solutions can streamline data collection, storage, and processing, thereby improving efficiency and accuracy.

4. The fourth part of the document addresses the challenges associated with data management, such as data quality, security, and privacy. It provides strategies to mitigate these risks and ensure that the data remains reliable and secure throughout its lifecycle.

5. The fifth part of the document discusses the importance of data governance and the establishment of clear policies and procedures. It emphasizes that effective data governance is crucial for ensuring that data is used responsibly and in compliance with relevant regulations.

6. The sixth part of the document explores the role of data in decision-making and strategic planning. It highlights how data-driven insights can help organizations identify opportunities, assess risks, and make informed decisions that drive growth and success.

7. The seventh part of the document discusses the importance of data literacy and the need for ongoing training and development. It emphasizes that all employees should have a basic understanding of data and be able to interpret and use it effectively in their work.

8. The eighth part of the document discusses the importance of data ethics and the need to consider the social and ethical implications of data collection and use. It emphasizes that organizations should be transparent about their data practices and respect the privacy and rights of individuals.

9. The ninth part of the document discusses the importance of data security and the need to implement robust security measures to protect data from unauthorized access, loss, or theft. It emphasizes that data security is a top priority for any organization that handles sensitive information.

10. The tenth part of the document discusses the importance of data integration and the need to ensure that data from different sources is consistent and interoperable. It emphasizes that data integration is essential for providing a comprehensive view of the organization's operations and for enabling cross-functional collaboration.

### III INTERACTIVE SYSTEM

The model use is dependent on the data files. A data file contains the structure and all parameters pertaining to a given project. The user may use one of the files provided (see Volume IV) or create a new one (see Section IV of this volume). The file used is referred to as the base case file. For purposes of analysis, the user creates a test case by making interactive changes to the base case. Then, comparisons, base to test may be made. Further, if desired, the test case may be saved as a new permanent base case for future use.

Only two routines are moderately "base case independent"--the pre-processing enforcement routine and the post-processing statistical testing routine. For these, data may be input or evaluated which are contradictory or extraneous to the base case data file material. Base case or current test case material may, of course, also be used. The main modeling routine is base case dependent.

As mentioned previously, one project involving Citizens Band Radio is a totally separate routine and, while it operates under the same interactive system as the flow models, it is not discussed in this volume.

The following sections serve as a user's guide, describing the series of steps that a user must take to access DEMON, input data and produce output.

#### A. System Access

First, the user checks the terminal settings. They should be 30CPS, Half Duplex, On-Line, Terminal-On. Next, the proper NIH computer telephone number for the terminal in use is dialed. An entire list of telephone numbers is given in the front of the NIH Computer Users' Guide, but an

abbreviation of system TSO numbers is:

(301)	654-8610	for TTY's
(301)	654-8514	for IBM 2741's
(301)	652-6451	for 1200 Baud

The user should hear a high-pitched tone when the connection has been established, at which time the phone is placed into the acoustic coupler. The carrier light should go on. The user hits two carriage returns to get the attention of the computer, which replies:

'ENTER LOGON'.

The user responds:

*'logon account-initials/terminal-id/box-number'*.

After sending system messages, TSO will send its herald,

'READY'.

Any time the user sees this herald, it means that TSO is waiting for a command. The command to initiate the program execution procedure is

*'ex demon2'*.

Users having difficulty with the above procedures should call the NIH PAL Unit at (301) 496-5525 for assistance.

First the user will be given an option to use the Citizens Band Radio simulation model, then to compute increased enforcement effects, and then to analyze a treatment program.

The first option, to use the Citizens Band simulation model, is documented in Volume III.

B. Enforcement

In the DWI Enforcement computations, two areas of a jurisdiction having similar characteristics, called Area A and Area B, are selected. A task force of officers is first assigned to Area A to increase DWI surveillance and apprehension. This effort is supplemented by an intensive public information campaign. The task force then moves to Area B, repeating the procedure. Each activity, Phase I (in Area A), Phase II (in Area B) is conducted for the same length of time.

If the user does not want to use the Citizen Band Radio model and does want to compute enforcement effects, the answer is "N" for No on the former and "Y" for Yes on the latter. Having indicated "Y" to enforcement, five categories of 27 parameters are first identified.

WELCOME TO DEMON

DO YOU WANT TO USE THE CITIZEN BAND RADIO SIMULATION MODEL?

N

DO YOU WANT TO COMPUTE INCREASED ENFORCEMENT EFFECTS?

Y

ENFORCEMENT MODEL

FIRST, 27 PARAMETERS MUST BE SPECIFIED. THE FIVE CATEGORIES OF PARAMETERS ARE:

1. POPULATION
2. DETERRENCE
3. ACCIDENT RATES
4. ENFORCEMENT
5. COSTS

1. Population Parameters

There are four parameters in the first category of Population.

1. POPULATION PARAMETERS

WHAT IS THE NUMBER OF LICENSED DRIVERS IN AREA A?

..  
63000

WHAT IS THE PROPORTION OF LICENSED DRIVERS IN A THAT DRINK AND DRIVE?

..  
.5

WHAT IS THE NUMBER OF LICENSED DRIVERS IN AREA B?

..  
63000

WHAT IS THE PROPORTION OF LICENSED DRIVERS IN B THAT DRINK AND DRIVE?

..  
.5

To input the number desired after each question, wait for ..., input the number and hit the carriage return which will signal the computer that input is complete. There are built in checks for data limits, and error messages will appear if the input data is incorrect. For example, the proportion must be between 0 and 1 for the questions above.

2. Deterrence Parameters

There are eight parameters in the second category of Deterrence.

2. DETERRENCE PARAMETERS

WHAT IS THE MAXIMUM PROPORTION OF THE POPULATION IN AREA A WHICH CAN BE  
DETERRED WITH ENFORCEMENT AND INFORMATION CAMPAIGNS AND AT WHAT TIME (IN WEEKS)  
WILL THIS MAXIMUM DETERRENCE OCCUR?

..  
.15,52.

WHAT IS THE MAXIMUM PROPORTION OF THE POPULATION IN AREA B WHICH CAN BE  
DETERRED WITH ENFORCEMENT AND INFORMATION CAMPAIGNS AND AT WHAT TIME (IN WEEKS)  
WILL THIS MAXIMUM DETERRENCE OCCUR?

..  
.15,52.

WHAT IS THE MAXIMUM PROPORTION OF THE POPULATION IN AREA A WHICH CAN BE  
DETERRED WITH ONLY AN INFORMATION CAMPAIGN AND AT WHAT TIME (IN WEEKS)  
WILL THIS MAXIMUM DETERRENCE OCCUR?

..  
.03,73.

WHAT IS THE MAXIMUM PROPORTION OF THE POPULATION IN AREA B WHICH CAN BE  
DETERRED WITH ONLY AN INFORMATION CAMPAIGN AND AT WHAT TIME (IN WEEKS)  
WILL THIS MAXIMUM DETERRENCE OCCUR?

..  
.03,73.

These parameters are input in series, separated by a comma. Specific units required will be indicated. For example, the time units above must be in weeks.

### 3. Accident Rate Parameters

There are eight parameters in the third category of Accident Rates.

#### 3. ACCIDENT RATE PARAMETERS

PLEASE INPUT THE FOLLOWING 4 ACCIDENT RATES FOR AREA A:

1. ACCIDENTS/PERSON-YEAR FOR NON-DRINKERS
2. ACCIDENTS/PERSON-YEAR FOR DETERRED DRINKERS
3. ACCIDENTS/PERSON-YEAR FOR NON-DETERRED DRINKERS WITH NO ARRESTS
4. ACCIDENTS/PERSON-YEAR FOR NON-DETERRED DRINKERS WITH ARRESTS

..  
.07, .53, 1.22, .94

PLEASE INPUT THE FOLLOWING 4 ACCIDENT RATES FOR AREA B:

1. ACCIDENTS/PERSON-YEAR FOR NON-DRINKERS
2. ACCIDENTS/PERSON-YEAR FOR DETERRED DRINKERS
3. ACCIDENTS/PERSON-YEAR FOR NON-DETERRED DRINKERS WITH NO ARRESTS
4. ACCIDENTS/PERSON-YEAR FOR NON-DETERRED DRINKERS WITH ARRESTS

..  
.07, .53, 1.22, .94

### 4. Enforcement Parameters

There are five parameters in the fourth category of Enforcement.

#### 4. ENFORCEMENT PARAMETERS

WHAT IS THE CURRENT NUMBER OF TASK FORCE UNITS?

..  
8

HOW MANY DRINKING DRIVERS PER HOUR CAN THE TASK FORCE OBSERVE?

..  
10

WHAT IS THE BOOKING RATE (ARRESTEES PER HOUR)?

..  
.7

HOW MANY HOURS PER WEEK DOES EACH TASK FORCE WORK?

..  
16

WHAT IS THE PROJECT OPERATIONAL TIME IN WEEKS (FOR PHASES I AND II)?

..  
180

## 5. Cost Parameters

There are two cost parameters to be specified.

### 5. COST PARAMETERS

WHAT IS THE ESTIMATED COST TO SOCIETY PER ACCIDENT?

..  
15000

WHAT IS THE HOURLY COST OF THE TASK FORCE UNIT?

..  
13

After all 27 parameters have been initially identified, the user is given the option to change any of the parameters.

DO YOU WANT TO CHANGE ANY OF THE PARAMETERS?

..  
Y

PARAMETER TYPES:

1. POPULATION
2. DETERRENCE
3. ACCIDENT RATES
4. ENFORCEMENT
5. COSTS

ENTER DESIRED PARAMETER TYPE

..  
♦

If the user had wanted to change a parameter, he would have entered a parameter type number from 1 to 5. A list of the current parameter values would be displayed and he would be requested to enter the new desired value. An asterisk (\*) indicates that no change is desired.

## 6. Enforcement Output

The enforcement output is given when no further changes are requested:

## ENFORCEMENT OUTPUT

	PHASE 1		PHASE 2		CONTROL	
	A	B	A	B	A	B
NUMBER DETERRED	3397	1443	2834	4419	-----	-----
NO. TASK FORCE ARR.	1003	-----	-----	1003	-----	-----
TASK FORCE HOURS	11520.0	-----	-----	11520.0	-----	-----
TASK FORCE COSTS	207350.00	-----	-----	207350.00	-----	-----
NONDRINKER CRASHES	3316	3316	3316	3316	3316	3316
DET. DRINKER CRASHES	3469	1474	2894	4512	-----	-----
DRINKING NO ARR. CRASH	57212	63466	60529	55054	66513	66513
TASK FORCE ARR CRASH	820	-----	-----	820	-----	-----
TOTAL CRASHES	65317	68756	67239	64202	70329	70329
COST SAVINGS, \$	74972640.	23594992.	46350000.	91697632.	-----	-----
TOTAL SAVINGS = \$	236615264.	-----	-----	-----	-----	-----

The table shows project performance (number of people deterred, number of arrests, costs, crashes, etc.) for each of the two areas, Area A and Area B, during Phase 1 and Phase 2, and compares these with a control (no increased enforcement in Area A or B).

Next, the user may specify a rerun code to either continue to work with the enforcement routine, to analyze a program, or end the computer session.

RERUN CODES ARE:  
 1 = CHANGE ENFORCEMENT PARAMETERS  
 2 = ANALYZE A TREATMENT PROGRAM  
 CARRIAGE RETURN = END PROGRAM

### C. Treatment Programs

#### 1. Retrieving Data Files

DEMON relies on a previously created data file to describe the demonstration projects. To remain flexible, the data file is not associated with the program at the time the program files are being allocated. Rather,

the user is prompted interactively to enter the file name of the data file to be examined. In this way, the user may, at one session, analyze any number of different project data files by DEMON.

There are two different types of data files used for DEMON: a Readable Data File and a Binary Data File. A Readable Data File has the advantage of being readable by both man and machine, but the disadvantages are that it is slower, thus more costly, and it is a valid format for a base case only. A test case which is read in must be in the Binary Data File format. A test case which is derived interactively from the base case has no such requirement, of course. The advantages of the Binary Data File format are that it is a valid format for both the base and test case and it is a faster and thus less expensive form of input/output; however, it is not readable by man.

At the beginning of execution, the user and DEMON have the following conversation:

```
EX DEMON2
WELCOME TO DEMON
DO YOU WANT TO USE THE CITIZENS BAND RADIO SIMULATION MODEL?
..
N
DO YOU WANT TO COMPUTE INCREASED ENFORCEMENT EFFECTS?
..
N
YOU MAY NOW ANALYZE A TREATMENT PROGRAM
ENTER BASE CASE FILENAME
PROBA.DATA
```

DEMON will search for the data file named PROBA.DATA, associate it with logical unit 1, and read in the data as the base case (see Appendix A, Volume III for PROBA.DATA project flow diagram and data files; see also Figure 1). All files reside on disk pack FILE16. The most common errors that can occur in this allocation are as follows:

<u>Error Code</u>	<u>Exploration</u>
10	File in Use.
12	File Not Found. Check spelling of filename or residence on FILE16.
320	Bad Data Set Name. Too many or invalid characters in data set name.
20	Another file is currently associated with this logical unit number.

For a more complete list, the user is directed to NIH documentation.

After the base case has been initialized by reading in the data file, DEMON asks

```
DO YOU WANT TO READ TEST CASE FROM A FILE?
..
N
```

A 'NO' response would cause the test case to be initialized identical to the base case. A 'YES' response would cause DEMON to prompt the user for a file name of a file previously saved interactively. Thus, the file would have to be a Binary Data File that is compatible with the base case specified, and must also reside on FILE16. By a compatible data file, it is meant that the file must have the same number of population groups and stages, the same flowpaths, and same stage types. The branching ratios and stage data may be different.

The input data file is closed and released immediately after having been read, thus freeing logical unit 1 for future input or output assignments.

## 2. Groupings

A data file may contain more than one demographic grouping of the target population. If such is the case, the user is asked if he wishes to

see the groupings. This listing is a good reference for future possible changes of branching ratios and system flow which are group dependent.

Following is an example of such a listing:

```
DO YOU WANT TO SEE GROUPS?  
..  
Y  
  
GROUPS FOR THIS FILE ARE:  
1 MALE, 14-18, LOW-MIDDLE SOCIOECON, HIGH SCHOOL  
2 MALE, 14-18, LOW-MIDDLE SOCIOECON, COLLEGE+  
3 MALE, 14-18, MIDDLE-UPPER SOCIOECON, HIGH SCHOOL  
4 MALE, 14-18, MIDDLE-UPPER SOCIOECON, COLLEGE+  
5 MALE, 19-25, LOW-MIDDLE SOCIOECON, HIGH SCHOOL  
6 MALE, 19-25, LOW-MIDDLE SOCIOECON, COLLEGE+  
7 MALE, 19-25, MIDDLE-UPPER SOCIOECON, HIGH SCHOOL  
8 MALE, 19-25, MIDDLE-UPPER SOCIOECON, COLLEGE+  
9 FEMALE, 14-18, LOW-MIDDLE SOCIOECON, HIGH SCHOOL  
10 FEMALE, 14-18, LOW-MIDDLE SOCIOECON, COLLEGE+  
11 FEMALE, 14-18, MIDDLE-UPPER SOCIOECON, HIGH SCHOOL  
12 FEMALE, 14-18, MIDDLE-UPPER SOCIOECON, COLLEGE+  
13 FEMALE, 19-25, LOW-MIDDLE SOCIOECON, HIGH SCHOOL  
14 FEMALE, 19-25, LOW-MIDDLE SOCIOECON, COLLEGE+  
15 FEMALE, 19-25, MIDDLE-UPPER SOCIOECON, HIGH SCHOOL  
16 FEMALE, 19-25, MIDDLE-UPPER SOCIOECON, COLLEGE+
```

These groups can not be changed interactively in a test case.

### 3. Changing the Test Case

Next, the test case data may be altered before producing output and performing statistical analysis. The possible alterations of the test case have been grouped into nine categories called Data Types. The interactive sequence for each Data Type proceeds as follows. At the first level of program interaction, DEMON asks the user whether the current test data set is to be changed or to be displayed for viewing. A 'yes' reply would cause the program to enter the appropriate Data Type alteration routine, which would lead to further questioning. A 'no' reply would cause the

program to proceed to the first level of interaction for the next Data Type. The Data Types are ordered as follows:

1. Target Group Generator
2. System Flows
3. Branching Ratios
4. Costs
5. Time Intervals
6. Workloads
7. Recidivism
8. Tracking
9. Project Life

The above sequence applies for the first time a user analyzes a particular base and test case. After the first analysis has been completed, and if a rerun code of 1 is entered, the Data Types are merely listed and the user is asked to specify the number of the Data Type to be displayed or changed. As long as analysis continues of the base and test case files, the most recent changes are maintained in the test case.

a. Data Type 1 - Specification of Target Group Generator

The Target Group Generator is a visual representation delineating the flow of population arriving at the project target group. When entering data type 1, the user is first given the option to view the Target Group Generator. It is output\* with the test case data, thus reflecting any changes that might be made.

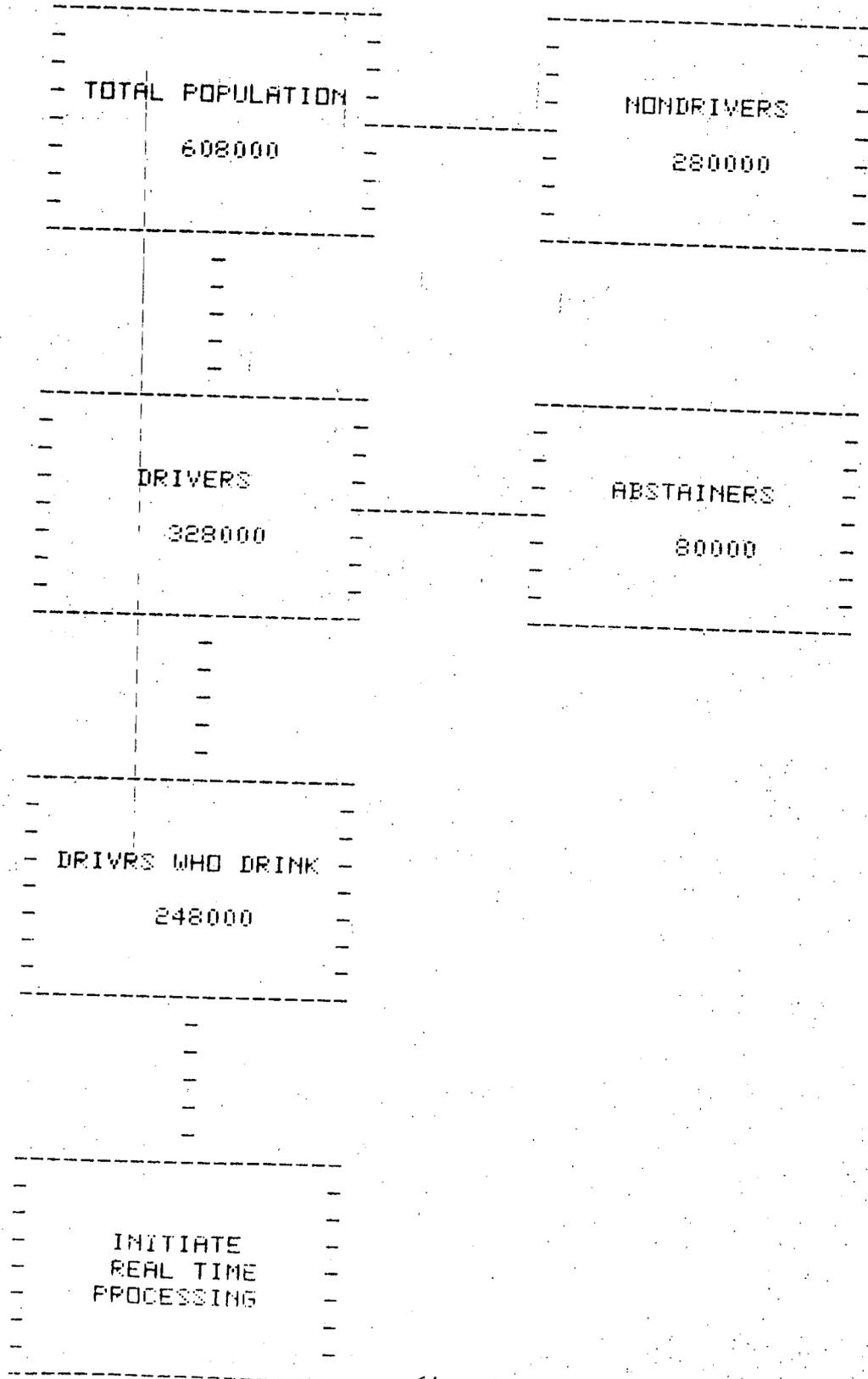
DO YOU WANT TO CHANGE OR SEE THE TARGET GROUP GENERATOR DATA?

Y

---

\* Note: All DEMON output is screen sized to 26 lines for CRT viewing. This means after each continuous output of 26 lines, DEMON output will stop until the user prompts with a carriage return.

PROBATION  
TARGET GROUP GENERATOR



The user is next asked if he wishes to change the target group generator data. If he answers "yes", Target Group Generator data codes, based on the data just displayed, are listed and the user may make changes by indicating the code number and the respective change in numerical value.

DO YOU WANT TO CHANGE THE TARGET GROUP GENERATOR DATA?

..  
Y

TARGET GROUP GENERATOR DATA CODES:

1.	TOTAL POPULATION	503000
2	NONDRIVERS	280000
3	DRIVERS	323000
4	ABSTAINERS	30000
5	DRIVERS WHO DRINK	243000

ENTER DESIRED DATA CODE NUMBER

..  
5

ENTER CHANGE IN NUMERICAL VALUE

..  
2000

ENTER DESIRED DATA CODE NUMBER

..  
\*

The asterisk (\*) indicates that no further data codes are of interest at this time.

After the user has indicated that no additional changes in data are desired in all nine phases, the program then checks the data feasibilities for changes in the Target Group Generator. If a shortage exists, an error message is displayed.

TARGET GROUP GENERATOR DATA IS NOT COMPATIBLE WITH SYSTEM FLOW  
GROUP SIZE SHOULD BE GREATER THAN 5143.  
SYSTEM FLOW TO STAGE 1 IS 33. PER WKS.  
PROJECT OPERATIONAL TIME IS 156. WKS.  
LAST STAGE OF TARGET GROUP GENERATOR:  
DRIVERS WHO DRINK = 2000

In this example, the change made in the target group generator data has created a shortage. The population size as indicated by the target group generator is too small to meet system flow requirements. ( $2000 < 33 \times 156$ ).

The user is not allowed to proceed until a change in data has been made to correct the situation. The opportunity to change the data to correct the shortage is provided:

RERUN CODES:

1. CHANGE OR SEE DATA
  2. READ IN A TEST CASE FROM A FILE
  3. READ IN NEW BASE CASE OR USE CB OR ENFORCEMENT MODELS
- CARRIAGE RETURN = END PROGRAM

ENTER RERUN CODE

..  
1

DATA TYPE CODES:-

1. TARGET GROUP GENERATOR
2. SYSTEM FLOWS
3. BRANCHING RATIOS
4. COSTS
5. TIME INTERVALS
6. WORKLOADS
7. RECIDIVISM
8. TRACKING
9. PROJECT LIFE

One of three changes may be made:

1. The target group generator population may be increased to meet the required group size (at least 5148).
2. The system flow rate may be reduced (12 persons/week or less).
3. The project operational time may be reduced (60 weeks or less).

One of these changes is shown below:

Target Group Generator adjustment:

ENTER DESIRED DATA TYPE NUMBER

..  
1

DATA TYPE 1 - SPECIFICATION OF TARGET GROUP GENERATOR

DO YOU WANT TO SEE THE TARGET GROUP GENERATOR?

..  
N

TARGET GROUP GENERATOR DATA CODES:

1	TOTAL POPULATION	602000
2	NONDRIVERS	290000
3	DRIVERS	322000
4	ABSTAINERS	90000
5	DRIVERS WHO DRINK	2000

ENTER DESIRED DATA CODE NUMBER

..  
5

ENTER CHANGE IN NUMERICAL VALUE

..  
5200

ENTER DESIRED DATA CODE NUMBER

..  
0

ENTER DESIRED DATA TYPE NUMBER

..  
0

b. Data Type 2 - Specification of Rate of System Flow

To change or see the rate of system flow, the user is asked to 'ENTER STAGE NUMBER, INPUT TYPE CODE'. There are two possible input type codes: '1' and '2'. A '1' indicates that the user will input an absolute value and a '2' indicates that a relative or percentile value will be input. A typical input format would be '5, 1', indicating stage number 5 and input type code 1. If working with a file containing more than one

demographic grouping, the user will be asked to indicate a group number for each stage number given. In response the user is given the current flow rate per standard time unit, stage number, stage name and group number, if applicable. Changes to the data can then be made, by providing a new flow rate (input code 1) or a percentage increase (or decrease) of the existing flow rate (input code 2). If the flow rate is changed for any stage other than number 1, new flow rates are assigned to all stages. Therefore, the user should exercise caution with Data Type 2.

Following is an example using the file TYOUNG.DATA which uses the groups feature (see Appendix C, Volume III for TYOUNG.DATA project flow diagram and data files).

```
DO YOU WANT TO CHANGE OR SEE THE TARGET GROUP GENERATOR DATA?
..
N

DO YOU WANT TO CHANGE OR SEE THE RATE OF SYSTEM FLOWS?
..
Y

DATA TYPE 2 - SPECIFICATION OF RATE OF SYSTEM FLOWS

ENTER STAGE NUMBER, INPUT TYPE CODE
..
15,1
ABSOLUTE FLOWS FOR STAGE 15 - MM7 NP

ENTER GROUP NUMBER
..
14
CURRENT FLOW OF 2.6 PER WKS. FOR STAGE 15 MM7 NP FOR GROUP 14
ENTER CHANGE
..
*

ENTER STAGE NUMBER, INPUT TYPE CODE
..
*
```

In this phase, as in other phases, when the user has completed changes for a given stage or only wishes to view the data, an asterisk is entered. If there is no further interest in the Data Type, an asterisk is entered again.

c. Data Type 3 - Specification of Branching Ratios

When entering this phase, the user is asked to input a stage number for data to be displayed or changed. As in Data Type 2, if working with a file containing more than one population group, the user will be asked for a group number for each stage number indicated. The name of the stage, the names of the stages to which it flows and the associated branching ratios are printed for the user's information. The user is then asked to 'ENTER CHANGE.' If no changes to that stage are desired, an asterisk '\*' is the correct response, leaving the data as they were. If a change is desired, the new numerical values are interactively input. The inputs are probabilities, reading from top to bottom on the user information output. All probabilities are input, in the same order, whether changed or not. Actually, any numbers may be input, but if the probabilities of branching do not add to one, the program will normalize the input values according to the ratios of data input, so that they sum to one.

Following is an example, again using the file TYOUNG.DATA with groups.

```
DO YOU WANT TO CHANGE OR SEE BRANCHING RATIOS?
..
Y

DATA TYPE 3 - SPECIFICATION OF BRANCHING RATIOS

ENTER STAGE NUMBER
..
15

ENTER GROUP NUMBER
..
12
STAGE 15 - MM7 NP          FOR GROUP 12
GROUP NUMBER 12
CURRENT RATIOS FOR STAGE 15 MM7 NP      ARE
POSTEST T NP          1.00
ENTER CHANGES
..
◇
```

The user will then be asked again to 'ENTER STAGE NUMBER' and the procedure is repeated. When no further changes to Data Type 2 are desired, the user response to the request for a stage number is an asterisk. Next, changes to another data type may be made.

d. Data Type 4 - Specification of Costs

After indicating a desire to change or see costs, the user is again asked to 'ENTER STAGE NUMBER.' Only certain stage types (A, D, M, K, S, V) have cost information associated with them. If the user enters a stage number of an inappropriate stage type, DEMON answers 'PARAMETERS UNACCEPTABLE FOR THIS MODIFICATION' and asks for another stage number, 'ENTER STAGE NUMBER'. When an acceptable stage number is given, the current wages for the standard time unit associated with that stage are printed. Any changes in the data are then requested. Next the current fees per person for the stage are given (Stage Types K and M only) and any changes are requested.

For S and V type stages, a tracking cost per person is displayed.

```
DO YOU WANT TO CHANGE OR SEE COSTS?
..
Y
DATA TYPE 4 - SPECIFICATION OF COSTS
ENTER STAGE NUMBER
..
15
CURRENT WAGES FOR STAGE 15 SCHOOL NP ARE $ 290.00 PER WKS.
ENTER NEW WAGES
..
♦
CURRENT FEES FOR STAGE 15 SCHOOL NP ARE $ 30.00 PER PERSON
ENTER NEW FEES
..
♦
~
ENTER STAGE NUMBER
..
♦
```

This is an M stage in PROBA.DATA.

e. Data Type 5 - Specification of Time Intervals

The first request made of the user is again to enter a stage number. The only acceptable stage types in this phase are A, D, E, K, M, S, and V. Other stage types requested will result in the message shown above as in Data Type 4. When an A or D type stage type is indicated by the user's stage number, DEMON will print the current time spent with worker. When a K or M stage type is indicated, DEMON will output both current time spent with worker and current time spent in the stage. When an E stage type is indicated, the current time between group assignments and the current time spent with worker are displayed. For S or V type stages, a tracking time per person is displayed. Changes may be made for each item, separately.

```
DO YOU WANT TO CHANGE OR SEE TIME INTERVALS?
..
~Y

DATA TYPE 5 - SPECIFICATION OF TIME INTERVALS

ENTER STAGE NUMBER
..
5
STAGE 5 - ASSIGN D NP

CURRENT TIME SPENT IN STAGE IS 1.000 WKS.
ENTER CHANGE
..
◇

CURRENT TIME SPENT WITH WORKER IS 0.005 WKS.
ENTER CHANGE
..
◇

ENTER STAGE NUMBER
..
◇
```

This is a K stage in PROBA.DATA.

f. Data Type 6 - Specification of Workload Data

The first request of the user is to enter a stage number. The acceptable stage types for this phase are A, D, E, K, and M. Other stage types will result in an unacceptable stage message. If an A or D stage type is indicated, current number of servers and worker availability are printed. If a K or M stage type is indicated, DEMON outputs the current number of individuals per group. If an E stage type is indicated, both current number of groups per worker and current number of servers are presented. As in other Data Types, the user is given a change to make changes in each data item.

```
DO YOU WANT TO CHANGE OR SEE WORKLOAD DATA?
..
Y
DATA TYPE 6 - SPECIFICATION OF WORKLOAD PARAMETERS
ENTER STAGE NUMBER
..
M
CURRENT NUMBER OF INDIVIDUALS PER GROUP FOR STAGE 20 - PROBATION P IS 1
ENTER CHANGE
..
.
ENTER STAGE NUMBER
..
.
```

This is an M type stage in PROBA.DATA.

g. Data Type 7 - Specification of Recidivism Parameters

The user is asked for a stage number. The only acceptable stage types in this phase are S and V. Other stage types will result in an unacceptable stage message. Stage type S has associated with it up to 4 sets of 5 recidivism probabilities (not associated with treatment) while stage type V has twice as many—those for during treatment and those for after treatment. The sets of probabilities are: crash recidivism probabilities, DWI recidivism probabilities, violation recidivism probabilities, and probabilities of test score improvement.

When a user has indicated a stage number (a V in PROBA.DATA),  
a series of questions are asked:

```
DO YOU WANT TO CHANGE OR SEE RECIDIVISM PARAMETERS?
..
Y
DATA TYPE 7 - SPECIFICATION OF COMPONENTS OF RECIDIVISM
ENTER STAGE NUMBER
..
22
DO YOU WANT TO CHANGE OR SEE CRASH RECIDIVISM PROBABILITIES?
..
Y
CURRENT DURING TREATMENT TIME IS      4.00 WKS.
DURING TREATMENT PROBABILITIES:      0.9977  0.9022  0.0001  0.0000  0.0000
DO YOU WANT TO CHANGE THE TIME?
I..
..
Y
DO YOU WANT TO CHANGE THE PROBABILITIES?
..
N
CURRENT AFTER TREATMENT TIME IS      100.00 WKS.
AFTER TREATMENT PROBABILITIES:      0.9061  0.0330  0.0273  0.0161  0.0076
DO YOU WANT TO CHANGE THE TIME?
..
N
DO YOU WANT TO CHANGE THE PROBABILITIES?
..
N
DO YOU WANT TO CHANGE OR SEE DWI RECIDIVISM PROBABILITIES?
..
Y
CURRENT DURING TREATMENT TIME IS      4.00 WKS.
DURING TREATMENT PROBABILITIES:      0.9961  0.0033  0.0002  0.0000  0.0000
DO YOU WANT TO CHANGE THE TIME?
..
N
DO YOU WANT TO CHANGE THE PROBABILITIES?
..
N
CURRENT AFTER TREATMENT TIME IS      100.00 WKS.
AFTER TREATMENT PROBABILITIES:      0.8697  0.0487  0.0378  0.0237  0.0121
DO YOU WANT TO CHANGE THE TIME?
..
N
DO YOU WANT TO CHANGE THE PROBABILITIES?
..
Y
DO YOU WANT TO CHANGE OR SEE TEST SCORE DATA?
..
Y
THE TEST SCORE IMPROVEMENT PROBABILITIES ARE:
      25% - 0.070
      20% - 0.100
      15% - 0.120
      10% - 0.150
       5% - 0.200
ENTER FIVE NEW PROBABILITIES
..
.
ENTER STAGE NUMBER
..
.
```

In each case, if a positive response is given, the current time and probabilities are printed and the user is given a chance to make changes in each. The interactive portion will only indicate the probability sets which the data file utilizes; e.g., if the data file only has DWI arrest recidivism data, only the third question would be asked.

When a user has indicated a stage number of stage type V, the user will be given time and probabilities for both during and after treatment. Since a stage of type S does not have treatment associated with it, only one set of time and probabilities will be printed.

h. Data Type 8 - Specification of Demonstration Tracking

There is one item of information presented in this phase: tracking time. This data type does not apply to any particular stages but to the overall model. The user is asked in turn if the tracking time is to be viewed and/or changed. If there is a positive response, the current values are displayed and then the user may make any desired change.

```
DO YOU WANT TO CHANGE OR SEE THE TRACKING PARAMETER?  
..  
Y  
DATA TYPE 8 - SPECIFICATION OF TRACKING PARAMETER  
DO YOU WANT TO CHANGE OR SEE TRACKING TIME?  
..  
Y  
CURRENT TRACKING TIME IS 104.0000 WKS.  
ENTER NEW TRACKING TIME  
..  
♦
```

This means that for PROBA.DATA, individuals are tracked for 104 weeks (2 years).

i. Data Type 9 - Specification of Project Operational Time

This phase also applies to the overall model and allows the user to change or see the project operational time. The current value is shown first and the user is asked to make any changes.

DO YOU WANT TO CHANGE OR SEE THE PROJECT OPERATIONAL TIME?

..  
Y

DATA TYPE 9 - SPECIFICATION OF PROJECT OPERATIONAL TIME

CURRENT PROJECT OPERATIONAL TIME IS 156.00 WKS.  
ENTER CHANGE

..  
♦

This means that for PROBA.DATA, individuals are admitted to treatment for 156 weeks (3 years).

j. Summary of Interactive Input

In summary, a request of any data type sends the program into the particular phase which presents the current test case data to the user. The user is then allowed to change the test case if desired. In each phase, checks are built into the program to validate responses and if invalid, error messages are supplied (i.e., incorrect stage types, exceeding formatted data limits, etc.). As a general rule, an asterisk (\*) response indicates that the user does not want to see any more of the data associated with a particular question or phase, and DEMON then proceeds to the next item in the analysis--another item of data, another stage, another data type or, finally, output.

For the first analysis, the user is required to respond to all questions in sequence pertaining to desire to change or see data of each type. A final question is 'DO YOU WANT TO CHANGE OR SEE ANY DATA?' This allows the user to return to any of the questions for further modification or to check existing data before output. If 'yes', the data types are listed and the user selects them in any sequence.



The user is not allowed to proceed with the output portion of the program until the overload condition is corrected (in stages 12 and 13 in this example). The parameters provided are those which will affect a change according to the equations given in Section II for the particular queue type.

#### 4. Operations Output

When all desired data changes have been made and the new values are acceptable the output options are:

1. Incrementing of the project operational time
2. Stage-by-Stage Table
3. Summary Table
4. Caseload Diagram

Note that the output is on a screen size of 26 lines. After each continuous output of 26 lines, output will stop until the user prompts the terminal with a carriage return.

##### a. Incrementing the Project Operational Time

For a test case, the user will be permitted to time increment data up to the project operational time. No more than seven time increments are allowed and increments can be any length, as long as all increments sum to less than the project operational time. All increments must be in the standard time unit specified for the particular data file in use (e.g., weeks). Below is a sample run showing the table output for this feature.

DO YOU WANT TO INCREMENT THE PROJECT OPERATIONAL TIME?

..

Y

PROJECT OPERATIONAL TIME IS 155.00 WKS.

HOW MANY TIME INCREMENTS DO YOU WANT TO USE?

..

3

SPECIFY TIME INCREMENT NO. 1 IN WKS.

..

50

DO YOU WANT TO SEE THE OUTPUT FOR THIS INCREMENT?

..

Y

HERE IS THE OUTPUT FOR INCREMENT NO. 1 OF 50.00 WKS.

PROBATION  
TABLE FOR INCREMENT NO. 1  
OF PROJECT OPERATIONAL TIME  
50.00 WKS.

STAGE	INDIVIDUALS THRU STAGE	WKS. OF WORK	COST	WKS. SPENT BY INDIVIDUAL	NUMBER IN STAGE
STAGE 1 DUI ARRESTS	1650	0.0	0.0	0.0	0
STAGE 2 ACQUIT	214	0.0	0.0	0.0	0
STAGE 3 CONV OR DI	1436	0.0	0.0	0.0	0
STAGE 4 CONDUCT PSI	1412	141.22	33991.766	0.91	23
STAGE 5 ASSIGN D NP	692	3.46	519.250	1.00	14
STAGE 6 ASSIGN D P	692	3.46	519.250	1.00	14
STAGE 7 TRAD SANC NP	141	1.75	-21910.605	9.00	32
STAGE 9 PRD SCH NP	150	0.0	0.0	6.29	23
STAGE 9 PRD SCH NP	150	0.0	0.0	6.29	23
STAGE 10 PRD NP	172	25.35	6202.910	0.17	1
STAGE 11 TRAD SANC P	141	14.00	-2210.602	9.00	32

STAGE 12 9 ST P	162	0.0	0.0	3.11	11
STAGE 13 9 PRG ST P	162	0.0	0.0	3.11	11
STAGE 14 9 PRG P	172	51.75	12419.337	0.12	0
STAGE 15 SCHOOL NP	150	2.00	-3951.102	0.0	0
STAGE 16 PRG SCH NP	150	24.44	-3934.909	0.0	0
STAGE 17 PROBATION NP	172	25.30	0.0	0.0	0
STAGE 18 GROUP TH P	162	5.30	5040.000	0.0	0
STAGE 19 PRG ST P	162	54.59	4352.599	0.0	0
STAGE 20 PROBATION P	172	51.60	0.0	0.0	0
STAGE 21 RECID TS NP	141	1.83	45.705	104.00	0
STAGE 22 RECID SCH NP	143	1857.07	46426.791	104.00	0
STAGE 23 VIOL SCH NP	8	0.0	0.0	0.0	0
STAGE 24 RECID PRS NP	143	1.86	45.427	104.00	0
STAGE 25 VIOL PRS NP	9	0.0	0.0	0.0	0
STAGE 26 RECID PR NP	164	2.13	53.199	104.00	0
STAGE 27 VIOL PR NP	9	0.0	0.0	0.0	0
STAGE 28 RECID TS P	141	1.83	45.705	104.00	0
STAGE 29 RECID ST P	146	1.99	47.313	104.00	0
STAGE 30 VIOL ST P	16	0.0	0.0	0.0	0
STAGE 31 RECID PRST P	146	1.99	47.313	104.00	0
STAGE 32 VIOL PRST P	16	0.0	0.0	0.0	0
STAGE 33 RECID PR P	155	2.02	50.454	104.00	0
STAGE 34 VIOL PR P	17	0.0	0.0	0.0	0

```

SPECIFY TIME INCREMENT NO. 2 IN WKS.
..
50
~
DO YOU WANT TO SEE THE OUTPUT FOR THIS INCREMENT?
..
N

SPECIFY TIME INCREMENT NO. 3 IN WKS.
..
50
DO YOU WANT TO SEE THE OUTPUT FOR THIS INCREMENT?
..
N

```

b. Stage-by-Stage Table

If the user wants to see the Stage-by-Stage Table, the table is output, showing the following information for each stage comparing the base and test cases: number of individuals who have passed through each stage, work expended, costs accrued, time spent by an individual in the stage and number trapped in the stage at the end of the project operational time. Since this output is quite lengthy, the user is given an option to discontinue the output after the first four stages. Following is an example (PROBA.DATA) of the Stage-by-Stage Table where the project operational time has been increased from 156 weeks to 208 weeks.

```

DO YOU WANT TO SEE STAGE BY STAGE OUTPUT TABLE?
Y

```

PROBATION  
STAGE BY STAGE OUTPUT TABLE

STAGE	STAGE ELEMENT	BASE	TEST	D/D CHANGE
STAGE 1 DNT ARRESTS	INDIVIDUALS THRU STAGE	5148	6864	33.33
	WKS. OF WORK FOR STAGE	0.0	0.0	0.0
	COST FOR ABOVE WORK	0.0	0.0	0.0
	WKS. SPENT BY INDIVIDUAL	0.0	0.0	0.0
	NUMBER IN STAGE	0	0	0.0
STAGE 2 ACQUIT	INDIVIDUALS THRU STAGE	669	892	33.33
	WKS. OF WORK FOR STAGE	0.0	0.0	0.0
	COST FOR ABOVE WORK	0.0	0.0	0.0
	WKS. SPENT BY INDIVIDUAL	0.0	0.0	0.0
	NUMBER IN STAGE	0	0	0.0

STAGE 3	INDIVIDUALS THRU STAGE	4479	5972	33.33
CONV OR DI	WKS. OF WORK FOR STAGE	0.0	0.0	0.0
	COST FOR ABOVE WORK	0.0	0.0	0.0
	WKS. SPENT BY INDIVIDUAL	0.0	0.0	0.0
	NUMBER IN STAGE	0	0	0.0
STAGE 4	INDIVIDUALS THRU STAGE	4455	5948	33.51
CONDUCT PSI	WKS. OF WORK FOR STAGE	445.54	594.83	33.51
	COST FOR ABOVE WORK	106929.94	142760.00	33.51
	WKS. SPENT BY INDIVIDUAL	0.91	0.91	0.0
	NUMBER IN STAGE	23	23	0.0

DO YOU WANT TO SEE THE REST OF THIS TABLE?

..  
Y

STAGE 5	INDIVIDUALS THRU STAGE	2213	2960	33.73
ASSIGN D NP	WKS. OF WORK FOR STAGE	11.07	14.80	33.71
	COST FOR ABOVE WORK	1659.75	2219.25	33.71
	WKS. SPENT BY INDIVIDUAL	1.00	1.00	0.0
	NUMBER IN STAGE	14	14	0.0
STAGE 6	INDIVIDUALS THRU STAGE	2213	2960	33.73
ASSIGN D P	WKS. OF WORK FOR STAGE	11.07	14.80	33.71
	COST FOR ABOVE WORK	1659.75	2219.25	33.71
	WKS. SPENT BY INDIVIDUAL	1.00	1.00	0.0
	NUMBER IN STAGE	14	14	0.0
STAGE 7	INDIVIDUALS THRU STAGE	521	708	35.82
TRAD SAND NP	WKS. OF WORK FOR STAGE	6.51	9.84	35.70
	COST FOR ABOVE WORK	-80761.75	-109699.44	35.83
	WKS. SPENT BY INDIVIDUAL	9.00	9.00	0.0
	NUMBER IN STAGE	32	32	0.0
STAGE 8	INDIVIDUALS THRU STAGE	531	717	35.16
O SCH NP	WKS. OF WORK FOR STAGE	0.0	0.0	0.0
	COST FOR ABOVE WORK	0.0	0.0	0.0
	WKS. SPENT BY INDIVIDUAL	6.29	6.29	0.0
	NUMBER IN STAGE	23	23	0.0
STAGE 9	INDIVIDUALS THRU STAGE	531	717	35.16
O PRO SCH NP	WKS. OF WORK FOR STAGE	0.0	0.0	0.0
	COST FOR ABOVE WORK	0.0	0.0	0.0
	WKS. SPENT BY INDIVIDUAL	6.29	6.29	0.0
	NUMBER IN STAGE	23	23	0.0
STAGE 10	INDIVIDUALS THRU STAGE	553	739	33.76
O PRO NP	WKS. OF WORK FOR STAGE	92.91	110.90	33.76
	COST FOR ABOVE WORK	19897.57	26615.72	33.76
	WKS. SPENT BY INDIVIDUAL	0.17	0.17	0.0
	NUMBER IN STAGE	1	1	0.0
STAGE 11	INDIVIDUALS THRU STAGE	521	708	35.82
TRAD SAND P	WKS. OF WORK FOR STAGE	52.10	70.70	35.70
	COST FOR ABOVE WORK	-7821.81	-10719.50	37.05
	WKS. SPENT BY INDIVIDUAL	9.00	9.00	0.0
	NUMBER IN STAGE	32	32	0.0

STAGE 12 O GT P	INDIVIDUALS THRU STAGE	542	729	34.42
	WKS. OF WORK FOR STAGE	0.0	0.0	0.0
	COST FOR ABOVE WORK	0.0	0.0	0.0
	WKS. SPENT BY INDIVIDUAL	3.11	3.11	0.0
	NUMBER IN STAGE	11	11	0.0
STAGE 13 O PRO GT P	INDIVIDUALS THRU STAGE	542	729	34.42
	WKS. OF WORK FOR STAGE	0.0	0.0	0.0
	COST FOR ABOVE WORK	0.0	0.0	0.0
	WKS. SPENT BY INDIVIDUAL	3.11	3.11	0.0
	NUMBER IN STAGE	11	11	0.0
STAGE 14 O PRO P	INDIVIDUALS THRU STAGE	553	740	33.75
	WKS. OF WORK FOR STAGE	165.87	221.85	33.75
	COST FOR ABOVE WORK	39908.70	53244.99	33.75
	WKS. SPENT BY INDIVIDUAL	0.12	0.12	0.0
	NUMBER IN STAGE	0	0	0.0
STAGE 15 SCHOOL NP	INDIVIDUALS THRU STAGE	531	717	35.16
	WKS. OF WORK FOR STAGE	6.75	9.00	33.33
	COST FOR ABOVE WORK	-14033.31	-19001.77	35.40
	WKS. SPENT BY INDIVIDUAL	0.0	0.0	0.0
	NUMBER IN STAGE	0	0	0.0
STAGE 16 PRO SCH NP	INDIVIDUALS THRU STAGE	531	717	35.16
	WKS. OF WORK FOR STAGE	86.25	116.58	35.16
	COST FOR ABOVE WORK	-14055.59	-19010.89	35.16
	WKS. SPENT BY INDIVIDUAL	0.0	0.0	0.0
	NUMBER IN STAGE	0	0	0.0
STAGE 17 PROBATION NP	INDIVIDUALS THRU STAGE	553	739	33.76
	WKS. OF WORK FOR STAGE	82.80	110.85	33.88
	COST FOR ABOVE WORK	0.0	0.0	0.0
	WKS. SPENT BY INDIVIDUAL	0.0	0.0	0.0
	NUMBER IN STAGE	0	0	0.0
STAGE 18 GROUP TH P	INDIVIDUALS THRU STAGE	542	729	34.42
	WKS. OF WORK FOR STAGE	20.40	27.30	33.82
	COST FOR ABOVE WORK	16319.99	21840.00	33.82
	WKS. SPENT BY INDIVIDUAL	0.0	0.0	0.0
	NUMBER IN STAGE	0	0	0.0
STAGE 19 PRO GT P	INDIVIDUALS THRU STAGE	542	729	34.42
	WKS. OF WORK FOR STAGE	192.98	245.96	34.42
	COST FOR ABOVE WORK	16264.81	21863.27	34.42
	WKS. SPENT BY INDIVIDUAL	0.0	0.0	0.0
	NUMBER IN STAGE	0	0	0.0
STAGE 20 PROBATION P	INDIVIDUALS THRU STAGE	553	740	33.75
	WKS. OF WORK FOR STAGE	165.60	221.70	33.88
	COST FOR ABOVE WORK	0.0	0.0	0.0
	WKS. SPENT BY INDIVIDUAL	0.0	0.0	0.0
	NUMBER IN STAGE	0	0	0.0
STAGE 21 RECID TS NP	INDIVIDUALS THRU STAGE	521	708	35.82
	WKS. OF WORK FOR STAGE	6.77	9.20	35.82
	COST FOR ABOVE WORK	169.34	229.99	35.82
	WKS. SPENT BY INDIVIDUAL	104.00	104.00	0.0
	NUMBER IN STAGE	0	0	0.0

STAGE 22	INDIVIDUALS THRU STAGE	504	682	35.16
REC'D SCH NP	WKS. OF WORK FOR STAGE	6555.09	8859.79	35.16
	COST FOR ABOVE WORK	163877.31	221494.81	35.16
	WKS. SPENT BY INDIVIDUAL	104.00	104.00	0.0
	NUMBER IN STAGE	0	0	0.0
STAGE 23	INDIVIDUALS THRU STAGE	27	36	35.16
VIOL SCH NP	WKS. OF WORK FOR STAGE	0.0	0.0	0.0
	COST FOR ABOVE WORK	0.0	0.0	0.0
	WKS. SPENT BY INDIVIDUAL	0.0	0.0	0.0
	NUMBER IN STAGE	0	0	0.0
STAGE 24	INDIVIDUALS THRU STAGE	504	682	35.16
REC'D PRS NP	WKS. OF WORK FOR STAGE	6.56	8.86	35.16
	COST FOR ABOVE WORK	163.88	221.50	35.16
	WKS. SPENT BY INDIVIDUAL	104.00	104.00	0.0
	NUMBER IN STAGE	0	0	0.0
STAGE 25	INDIVIDUALS THRU STAGE	27	36	35.16
VIOL PRS NP	WKS. OF WORK FOR STAGE	0.0	0.0	0.0
	COST FOR ABOVE WORK	0.0	0.0	0.0
	WKS. SPENT BY INDIVIDUAL	0.0	0.0	0.0
	NUMBER IN STAGE	0	0	0.0
STAGE 26	INDIVIDUALS THRU STAGE	525	702	33.76
REC'D PR NP	WKS. OF WORK FOR STAGE	6.83	9.13	33.76
	COST FOR ABOVE WORK	170.65	228.27	33.76
	WKS. SPENT BY INDIVIDUAL	104.00	104.00	0.0
	NUMBER IN STAGE	0	0	0.0
STAGE 27	INDIVIDUALS THRU STAGE	28	37	33.76
VIOL PR NP	WKS. OF WORK FOR STAGE	0.0	0.0	0.0
	COST FOR ABOVE WORK	0.0	0.0	0.0
	WKS. SPENT BY INDIVIDUAL	0.0	0.0	0.0
	NUMBER IN STAGE	0	0	0.0
STAGE 28	INDIVIDUALS THRU STAGE	521	708	35.82
REC'D TS P	WKS. OF WORK FOR STAGE	6.77	9.20	35.82
	COST FOR ABOVE WORK	169.34	229.99	35.82
	WKS. SPENT BY INDIVIDUAL	104.00	104.00	0.0
	NUMBER IN STAGE	0	0	0.0
STAGE 29	INDIVIDUALS THRU STAGE	488	656	34.42
REC'D GT P	WKS. OF WORK FOR STAGE	6.34	8.53	34.42
	COST FOR ABOVE WORK	158.58	213.17	34.42
	WKS. SPENT BY INDIVIDUAL	104.00	104.00	0.0
	NUMBER IN STAGE	0	0	0.0
STAGE 30	INDIVIDUALS THRU STAGE	54	73	34.42
VIOL GT P	WKS. OF WORK FOR STAGE	0.0	0.0	0.0
	COST FOR ABOVE WORK	0.0	0.0	0.0
	WKS. SPENT BY INDIVIDUAL	0.0	0.0	0.0
	NUMBER IN STAGE	0	0	0.0

STAGE 31 REC'D PRGT P	INDIVIDUALS THRU STAGE	498	656	34.42
	WKS. OF WORK FOR STAGE	6.34	8.53	34.42
	COST FOR ABOVE WORK	158.58	213.17	34.42
	WKS. SPENT BY INDIVIDUAL	104.00	104.00	0.0
	NUMBER IN STAGE	0	0	0.0
STAGE 32 VIOL PRGT P	INDIVIDUALS THRU STAGE	54	73	34.42
	WKS. OF WORK FOR STAGE	0.0	0.0	0.0
	COST FOR ABOVE WORK	0.0	0.0	0.0
	WKS. SPENT BY INDIVIDUAL	0.0	0.0	0.0
	NUMBER IN STAGE	0	0	0.0
STAGE 33 REC'D PR P	INDIVIDUALS THRU STAGE	498	666	33.75
	WKS. OF WORK FOR STAGE	6.47	8.65	33.75
	COST FOR ABOVE WORK	161.72	216.31	33.75
	WKS. SPENT BY INDIVIDUAL	104.00	104.00	0.0
	NUMBER IN STAGE	0	0	0.0
STAGE 34 VIOL PR P	INDIVIDUALS THRU STAGE	55	74	33.75
	WKS. OF WORK FOR STAGE	0.0	0.0	0.0
	COST FOR ABOVE WORK	0.0	0.0	0.0
	WKS. SPENT BY INDIVIDUAL	0.0	0.0	0.0
	NUMBER IN STAGE	0	0	0.0

c. Summary Table

The next output is the "Summary Output Table". For this output, the total system time delay for an individual, and costs/workloads accrued to treat all individuals (i.e., those reaching an exit stage during the project operational time) are computed, by exit stage. Overall system parameters and total project cost are also output. Both base and test case values are computed and percentage comparisons are made.

Following is an example of the Summary Table.

PROBATION SUMMARY OUTPUT TABLE					
PROJECT OPERATIONAL TIME IS 156.00 WKS. BASE AND 208.00 WKS. TEST					
SYSTEM FLOW RATE IS 33.00 PER WKS. BASE AND 33.00 PER WKS. TEST					
TRACKING TIME IS 104.00 WKS. BASE AND 104.00 WKS. TEST					
GROUP		NUMBER OF PEOPLE	WKS. OF WORK	COST	WKS. SPENT BY INDIVIDUAL
STAGE 2 - TYPE 2	BASE	669	0.0	0.0	0.0
ACQUIT	TEST	892	0.0	0.0	0.0

STAGE 21 - TYPE S	BASE	521	68.00	-67695.87	114.81
REC'D TS NP	TEST	708	92.35	-91941.87	114.81
STAGE 22 - TYPE V	BASE	504	6614.54	177420.75	112.10
REC'D SCH NP	TEST	682	8940.10	239790.12	112.10
STAGE 23 - TYPE Z	BASE	27	3.29	757.03	8.10
VIOL SCH NP	TEST	36	4.27	973.97	8.10
STAGE 24 - TYPE V	BASE	504	141.44	-718.53	112.10
REC'D PRS NP	TEST	682	191.17	-971.16	112.10
STAGE 25 - TYPE Z	BASE	27	7.10	-46.44	8.10
VIOL PRS NP	TEST	36	9.60	-62.77	8.10
STAGE 26 - TYPE V	BASE	525	219.47	32068.92	105.99
REC'D PR NP	TEST	702	293.53	42896.58	105.99
STAGE 27 - TYPE Z	BASE	28	11.10	1678.86	1.99
VIOL PR NP	TEST	37	14.83	2245.70	1.99
STAGE 28 - TYPE S	BASE	521	113.59	5249.50	114.81
REC'D TS P	TEST	708	154.27	7129.62	114.81
STAGE 29 - TYPE V	BASE	488	75.88	26875.20	108.93
REC'D GT P	TEST	656	102.00	36126.63	108.93
STAGE 30 - TYPE Z	BASE	54	7.79	3021.85	4.93
VIOL GT P	TEST	73	10.35	3963.72	4.93
STAGE 31 - TYPE V	BASE	488	222.26	26873.53	108.93
REC'D PRGT P	TEST	656	298.76	36123.57	108.93
STAGE 32 - TYPE Z	BASE	54	23.99	2968.33	4.93
VIOL PRGT P	TEST	73	32.25	3990.05	4.93
STAGE 33 - TYPE V	BASE	493	357.10	48305.34	105.94
REC'D PR P	TEST	686	477.70	64609.46	105.94
STAGE 34 - TYPE Z	BASE	55	38.89	5349.29	1.94
VIOL PR P	TEST	74	51.85	7154.79	1.94
♦♦ T O T A L S ♦♦	BASE			262107.31	
	TEST			352028.06	

d. Caseload Diagram

The next output allows the user to see a visual representation of the caseload for any of the treatment stages (stage types A, K, and M).

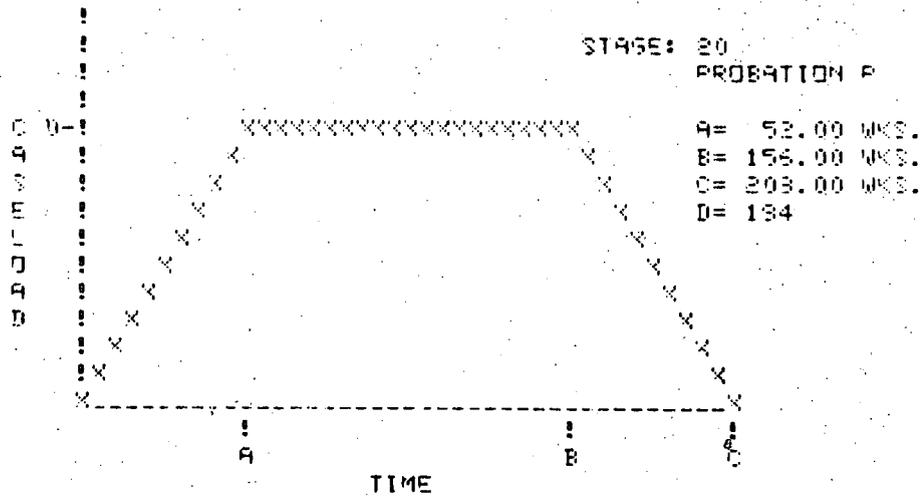
DO YOU WANT TO COMPUTE CASELOADS FOR ANY OF THE TREATMENT STAGES?

..

ENTER STAGE NUMBER

..  
20

CASELOAD DIAGRAM



KEY:

- A = TIME WHEN MAXIMUM CASELOAD IS REACHED
- B = TIME WHEN MAXIMUM CASELOAD BEGINS TO FALL OFF
- C = TIME WHEN TREATMENT IS COMPLETED
- D = MAXIMUM CASELOAD

ENTER STAGE NUMBER

This table shows the caseload for the probation workers in Stage 20, PROBA. DATA with two workers.

5. Statistical Testing on Recidivism or Test Score Data

This routine may be used to analyze project impact on the basis of recidivism and test score inputs.

Each data file used as a base case has up to four types of recidivism categories--DWI Arrests, Crashes, Violations or Test Score Improvements.

The user is first asked for a recidivism type to be used in testing

DO YOU WANT TO PERFORM STATISTICAL TESTS ON RECIDIVISM OR TEST SCORE DATA?

Y

DO YOU WANT TO TEST FOR CRASHES, ARRESTS, VIOLATIONS, OR TEST SCORES?

C

The objective of this testing is to measure differences in future behavior with respect to each such offense, experimental versus control. Thus, the user is next asked to input the stage number(s) for the experimental and control groups.

LIST THE OUTPUT STAGE NUMBERS FOR THE EXPERIMENTAL GROUP

22

LIST THE OUTPUT STAGE NUMBERS FOR THE CONTROL GROUP

21

If more than one stage number is used, i.e., if one wanted a composite control or experimental group, they are separated by commas and input on one line.

The following data are displayed (from PROBA.DATA).

HERE ARE THE RECIDIVISM DATA

NO. OF PEOPLE WITH	EXPERIMENTAL	CONTROL
NO CRASHES	456	470
1 CRASH	30	30
2 CRASHES	14	15
3 CRASHES	8	9

4 CRASHES	4	4
5+ CRASHES	2	3
SAMPLE SIZE	504	521
MEAN NO. OF OFFENSES/PERSON	0.1944	0.2073
PROPORTION OF NONOFFENDERS	0.9049	0.9021
SAMPLE VARIANCE	0.4820	0.5328

The user next has the choice of testing the proportion of non-offenders or the mean number of offenders.

```
DO YOU WANT TO TEST HYPOTHESIS 1 (PROPORTION OF NONOFFENDERS)
OR 2 (MEAN NUMBER OF OFFENSES)?
..
1
```

The Z statistic for hypothesis 1 is displayed.

Z1 = -0.1435

The user next has three additional options: to determine test power required, to determine sample size required, or to change the sample size.

a. Test Power

The user is asked to specify two items: test level and proportion of non-offenders (for hypothesis 1) for the experimental and control group. For hypothesis 2, the user would be asked to specify the mean. This input is followed with the test power.

```
DO YOU WANT TO CALCULATE TEST POWER?
..
Y
SPECIFY THE TEST LEVEL...
..
.05
```

SPECIFY THE EXPECTED PROPORTION OF NON OFFENDERS FOR  
THE EXPERIMENTAL GROUP FOLLOWED BY THE SAME FOR THE CONTROL GROUP...

..  
.9049..9021

THE TEST POWER = 0.0670

These values for proportions (or means for the other hypothesis) may be read from the previous table showing recidivism data, to determine the power of that test or for revised values that the user feels are more realistic than the ones shown. The sample size, though, is fixed as the value shown on the table.

b. Sample Size

To derive sample size the user must specify four items: the desired test level, proportion (for hypothesis 2, the mean) of offenders for the experimental and control groups, the desired test power, and the ratio of the control group size to the experimental group size. If values for the proportion and ratio are taken from the recidivism table, this sample size is the one required to obtain desired confidence with the data being considered.

DO YOU WANT TO CALCULATE SAMPLE SIZE?

..  
Y

SPECIFY THE TEST LEVEL...

..  
.05

SPECIFY THE EXPECTED PROPORTION OF NON OFFENDERS FOR  
THE EXPERIMENTAL GROUP FOLLOWED BY THE SAME FOR THE CONTROL GROUP...

..  
.9049..9021

SPECIFY THE TEST POWER...

..  
.9

SPECIFY THE RATIO OF CONTROL GROUP SIZE TO EXPERIMENTAL GROUP SIZE...

..  
1

The necessary sample sizes for the experimental and control groups are displayed.

THE EXPERIMENTAL GROUP SIZE = 147977

THE CONTROL GROUP SIZE = 147977

Since this sample size is very large, the user would probably attempt to reduce it by having proportions which are less close, numerically or by changing the stage used to comprise the experimental group. This sample size derivation can then be done again, since the user is next given the option of performing further statistical tests with the same data or different data.

```
DO YOU WANT TO PERFORM FURTHER STATISTICAL TESTS WITH
THE DATA YOU ALREADY HAVE...
..
N

DO YOU WANT TO PERFORM STATISTICAL TESTS WITH NEW DATA?
..
N
```

c. Changing the Sample Size

The user may now choose to change the flows so that some desired sample size for either the experimental or the control group is obtained.

```
DO YOU WANT TO CHANGE THE SAMPLE SIZE FOR EITHER THE EXPERIMENTAL OR
THE CONTROL GROUP?
..
Y

ENTER EITHER EXPERIMENTAL OR CONTROL
E
```

The present sample size is displayed and the user is asked to input a new sample size.

```
OLD SAMPLE SIZE =      504.

ENTER NEW SAMPLE SIZE FOR GROUP
..
550
```

Next, the ratio change is computed and applied to the system flows for all stages. Data compatibility checks are made. If an overload situation has been created by the change in system flow, a message is displayed.

DESIRED SAMPLE SIZE IS 550.

RATIO CHANGE IS 1.091

QUEUE OVERLOAD--PARAMETER CHANGE NECESSARY

STAGE 4 - CONDUIT PSI	ARRIVAL RATE	31.330
	NUMBER OF SERVERS	3
	ACTUAL TREATMENT TIME	0.100
	WORKERS AVAILABILITY	1.000

NEW SAMPLE SIZE CANNOT BE ACCOMMODATED BY PRESENT FLOW

The user must then make a change to correct the overload situation.

OPTIONS FOR CHANGES:

1. SYSTEM FLOW
2. TIME INTERVALS
3. WORKLOADS
4. BRANCHING RATIOS
5. SAMPLE SIZE

In this example, the user has adjusted the sample size to accommodate the system flow.

ENTER OPTION NUMBER

..  
5

ENTER EITHER EXPERIMENTAL OR CONTROL

E

OLD SAMPLE SIZE = 550.

ENTER NEW SAMPLE SIZE FOR GROUP

..  
504

DESIRED SAMPLE SIZE IS 504.

RATIO CHANGE IS 0.916

DO YOU WANT TO CHANGE THE SAMPLE SIZE FOR EITHER THE EXPERIMENTAL OR  
THE CONTROL GROUP?

..  
N

If the user indicates he does not want to make any further sample size changes, he now has the option of saving the test case he has created interactively.

#### 6. Saving Interactively Created Test Cases

Interactive conversation in the program allows the user to permanently save an interactively created test case. Options are as follows:

DO YOU WANT TO SAVE A BINARY DATA FILE FROM THE TEST CASE?

..  
N

DO YOU WANT TO SAVE A READABLE DATA FILE FROM THE TEST CASE?

..  
N

If the user had responded "yes" to either or both of these questions, he would have been requested to specify a name for the file. (See Section IV for conventions of naming a data file.) These saved data files will then be available for reading in as either a base or test case at any future session.

It is important to note that NIH storage charges will be made for these permanently catalogued data files. When the user no longer has use for any of these data files, they may be purged from the system with the TSO command.

'scratch (data file name)'

#### 7. Copy and Rerun Options

The user will next be asked to input a copy code.

COPY CODES:

0. NO COPY
1. COPY BASE CASE ONTO TEST CASE
2. COPY TEST CASE ONTO BASE CASE

ENTER COPY CODE

..  
0

The Copy Code is used to switch base and test case files. The user specifies a Copy Code prior to the Rerun Code which is requested next:

RERUN CODES:

1. CHANGE OR SEE DATA
2. READ IN A TEST CASE FROM A FILE
3. READ IN NEW BASE CASE OR USE CB OR ENFORCEMENT MODELS  
CARRIAGE RETURN = END PROGRAM

ENTER RERUN CODE

..

Any changes made by the Copy Code will already be in effect when the Rerun Code is used; i.e., the base and/or test case will be the ones which have been copied.

For example, answering with Rerun Code of '3' will completely restart execution by asking for a new base case such as YOUNG.DATA, another type of project:

RERUN CODES:

1. CHANGE OR SEE DATA
2. READ IN A TEST CASE FROM A FILE
3. READ IN NEW BASE CASE OR USE CB OR ENFORCEMENT MODELS  
CARRIAGE RETURN = END PROGRAM

ENTER RERUN CODE

..  
3

WELCOME TO DEMON

DO YOU WANT TO USE THE CITIZENS BAND RADIO SIMULATION MODEL?

..  
4

DO YOU WANT TO COMPUTE INCREASED ENFORCEMENT EFFECTS?

..  
4

YOU MAY NOW ANALYZE A TREATMENT PROGRAM

ENTER BASE CASE FILENAME  
YOUNG.DATA

whereas a Rerun Code of '0' or '1' leaves the base and test case as they are and allows further analysis. Rerun Code '2' allows the user to read in a new test case previously saved on a file.

#### 8. Logoff Procedure

To get a listing of time and charges, the user should request

'logoff'

```
READY  
LOGOFF  
CHARGE  
CPU TIME  
ELAPSED TIME|  
I/O COUNT  
REGION =
```

After charges are given the phone is removed from the coupler and the terminal set to off. The user may elect to simply disconnect the phone without requesting charges.

The user is directed to the publication, "370 Time Sharing Option Command Reference Manual," distributed by the Computer Center Branch, Division of Computer Research and Technology, National Institutes of Health, Bethesda, Maryland 20014, for a description of the commands available to the TSO user.

#### IV DATA FILE CONSTRUCTION

As previously discussed, many changes to the prepared DEMON files may be made interactively. If the user would like to prepare a totally new project data file, it can be constructed outside of DEMON by the methods described in the next section of this report. The user is advised to prepare a stage-by-stage flow diagram such as those shown in the Appendices and to examine data input for stage-to-stage cohesiveness prior to setting up a file.

Existing files may also be permanently modified. This would be done for primarily these reasons:

1. To correct errors in a new project file.
2. To change a stage type.
3. To add another type of recidivism.
4. To add or remove a countermeasure stage.

Other modifications are most easily made by interactive changes on a test case derived from a base case. A special feature of the program allows the user to save for future use a permanent copy of a test case created interactively. This is especially appropriate for making major data changes to an existing file.

To create a completely new file with a new flow, the user must enter TSO outside of DEMON. The TSO Reference Manual contains a complete description of all commands used. (See Section IV-A for discussion of system access.)

The following procedure is used to enter a new data file:

Dial NIH computer number for the terminal used. Depending on terminal, settings are as follows: online, 30CPS half-duplex, terminal on. When a high-pitched tone is heard on the phone, indicating that the computer is ready, place

phone in cradle (carrier light should go on) and hit two carriage returns. Computer will request LOGON:

'ENTER LOGON'

'logon account-initials/terminal-ID/Box-Number'

If LOGON is acceptable, the computer answers, requesting 'KEYWORD?'

If LOGON is not acceptable, either account is in use, or TSO is not active.

Type a 3-letter KEYWORD:

'KEYWORD? xxx'

Computer answers, indicating 'LOGON IN PROGRESS'.

When computer answers 'READY', type in the following command--  
'terminal linesize(80)'---required for DEMON files.

Computer answers 'READY'.

These LOGON commands and procedures are required to either create a file or modify one. Further procedures differ after the second 'READY'.

#### A. Entering a New Project File

To enter a new data file in the system, select a first data file name using six or fewer letters and type the following command:

'edit *first data file name.* data new nonum'

The letters in script are assigned to each new data file as unique identification. The computer answers 'INPUT'. Now, proceed with data file input. Data file format is given in Section C.

Two carriage returns in sequence will indicate termination of input, after which the computer answers 'EDIT'. This tells the user that this file may be modified before saving it. (See Section B for edit commands and procedures). Once editing is completed or if no editing seems to be required, the user can save the file. To save the file type the command, 'save' and the computer answers, 'SAVED'.

To get out of the edit mode, type the following command, 'end'. The computer answers 'READY'. A temporary file has been created and the user may either return to DEMON to use it on a short-term basis or create a permanent file.

To transfer a file from a temporary storage file to a permanent file location, the user selects a second data file name and types the following command:

```
'copy first data file name.data second data file name.  
data vol(file16) nonum'
```

The name of both files may be no longer than six characters and the only other restriction is that the first file name must differ from the second. A permanent data file has now been created and the computer answers 'READY'.

If no further work is desired, the next step is to LOGOFF, which is accomplished by typing the command, 'logoff'. The computer answers with cost and time information and automatically disconnects.

After the 'READY', the user may elect to do other things such as list the newly created file. This is accomplished by following 'READY' with

```
'list second data file name.data'
```

and the data file will be listed. The user may also enter DEMON and use this new file by appropriate calling of the program (see Section IV).

Another new project file may also be created following 'READY'.

#### B. Modification of an Existing Data File

The following procedure is used to modify an existing data file. The same LOGON procedure as for entering a new file is used. The next step is to provide an edit command:

```
'edit data file name.data'
```

The computer answers with a short description of the file:

'DATA SET data file name. DATA NOT LINE NUMBERED, USING NONUM'

and then 'EDIT'. A typical LOGON to edit mode sequence is shown below for a data file name PROBA.DATA:

'ENTER LOGON'

'logon account-initials/terminal ID/box number'

'KEYWORD?' 'xxx'

'LOGON IN PROGRESS AT date, time'

'TSO LINE 184'

'READY'

'terminal linesize(80)'

'edit proba.data'

'DATA SET PROBA.DATA NOT LINE NUMBERED, USING NONUM'

'EDIT'

Several commands are useful in scanning a data file and pointing to a particular line in the code which you wish to edit:

'top'--To get to the top of the data file.

'bottom'--To get to the bottom of the data file.

'Down'--Moves down one line of text. (The command  
'down 2' moves down 2 lines.)

'up'--Moves up one line of text. (The command 'up 2'  
moves up 2 lines).

'find'--To search a file for a particular wording, etc.  
(e.g., 'find \*stage 21\*'). After the word find is  
used an asterisk delimiter is used to indicate the  
beginning of information being looked for. The  
delimiter is followed by the wording being searched  
for, and that in turn is followed by the end delimiter.

Using these commands the user can reach the desired line of code. After each such command, the line of code to which the user is pointing is displayed, so that changes may be made. Some change commands are:

'delete'--Deletes the line of text where you are pointing.

'change'--To change a designated pointed string of characters to another string of characters (e.g., 'change \*21\*22\*'). In this example the string of characters 21, set off by asterisk delimiters, is being changed to the string of characters 22.

'insert'--This command is used to insert additional lines following the pointed line. Type the command 'insert' and the computer will answer 'INPUT', then begin inputting data. As many lines as desired may be input. End of input is indicated by hitting the carriage return twice in sequence. The computer will answer with 'EDIT' and the user may continue to make other changes.

At any time in the edit mode the complete listing of the current data file values may be viewed by making the command 'list'. When all editing is accomplished, type the following command to save the changes: 'save'. The computer will answer 'SAVED'. To get out of the edit mode, type 'end'. The computer will answer 'READY' and the user may proceed to enter DEMON or LOGOFF.

### C. Data Files and Format

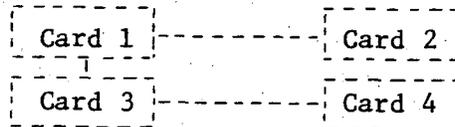
Examples of data files are given in Volume IV. Data files representing demonstration models currently being used are named PROBA.DATA (Probation), PSA.DATA (PROBA.DATA with different stage data), YOUNG.DATA (Young Problem Drivers), TYOUNG.DATA (YOUNG DATA with groupings), MOTOR.DATA (Motorcycle Licensing), DRVR.DATA (Driver Licensing), OFFEND.DATA (Offender Treatment), and SPC.DATA (Secondary Schools). These files are available to be used with DEMON.

If the user wishes to create a new file, the format shown on Table 2 should be used.

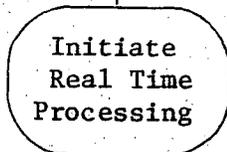
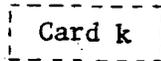
Table 2

DATA FILE FORMAT

Card Type Number or Order of Lines on Terminal	Definition	Format Restrictions
1	a) <u>READ</u> : These 4 letters must appear in 1st 4 columns of card 1. b) <u>Free-read</u> : The rest of the card is free-read and thus available for further identification of the data file (e.g., name of file and date).	A4, cc1-4 free-read, cc 5-80
2	<u>Name of File</u> : This is a 16-character alpha field. The name of the file should be centered in the first 16 columns for printout on target group generator and tables.	4A4, cc1-16
3	<u>Target Group Generator</u> : (number of cards varies from file to file). There must be an odd number of cards to accommodate the flow diagram output. Data are printed as follows:	



⋮



100

Table 2 (cont'd)

Card Type Number or Order of Lines on Terminal	Definition	Format Restrictions
	Each card consists of the following two parts:	
	a) <u>Title of Information</u> : 1st 16 characters of each card gives the name or title of information presented (e.g., TOTAL POPULATION)	4A4, ccl-16
	b) <u>Numerical Value of Information</u> : The next 8 characters represent the numerical value of previously given Title Information and is right justified (e.g., 690000)	I8, ccl7-24 Right justified
4	<u>4 asterisks</u> in the first 4 columns of the card immediately follow the end of information for Target Group Generator. This signals the end of this information.	****, ccl-4
5	<u>Number of groupings</u> : A real number, the number of groupings, followed by a blank may appear anywhere on the card. The card is free-read. After the blank, the card is available for comment.	F2.0 followed by blank, free-read
6	<u>Group Names</u> : If more than one group has been indicated in card 5, DEMON will expect a listing of the group names (one name per card and number of groups indicated in card 5). This is a alphanumeric field with a maximum of 72 characters.	18A4
7	a) <u>Project Operational Time</u> : Real number, right-justified in the 1st 5 columns, followed by blank--the time during which individuals are entered into system. Units are the standard time unit.	F5.0, ccl-5 right-justified, followed by blank in cc6.
	b) <u>Standard Time Unit</u> : (any reference to time within the system is expected to be in this time unit). This is a 4-character alpha field in cc7-10. Only possible inputs are: HRS., DAYS, WKS., MOS., YRS.	A4, cc7-10

Table 2 (cont'd)

Card Type Number or Order of Lines on Terminal	Definition	Format Restrictions
8	a) <u>Demonstration Tracking Time</u> : (in standard time unit, free-read). This is a real number, the time during which individuals' records are tracked, or followup is made. It is free-read and separated from next item of information on this card by a comma.  b) <u>Demonstration Tracking Cost</u> : Real (\$) followed by blank. After blank, comments may be put on the card.	Real, free-read followed by comma  Real, free-read followed by blank
9	4 asterisks in ccl-4	****,ccl-4
10	4 asterisks in ccl-4	****,ccl-4
<p>Cards 11-16 are repeated for each stage. The order of the input assumes the stage number, that is, the first stage input is stage 1, the second, stage 2, and so forth.</p>		
11	a) <u>Name of Stage</u> : This is a 12-character alpha field in ccl-12. b) <u>Blank</u> in ccl13. c) <u>Type of Stage</u> : Single alpha character in ccl14. The only acceptable stage types are A, D, E, G, H, J, K, L, M, N, S, V, or Z d) <u>Free-read</u> : Rest of card is free-read and available for comment (particularly useful for listing stage numbers, e.g., Stage 1).	3A4,ccl-12 cc-13 A1,ccl14  Free

Table 2 (cont'd)

Card Type Number  
or Order of Lines  
on Terminal

Definition

Format  
Restrictions

12

Stage Parameters (all are reals separated by commas, and, when applicable, in standard time unit). Parameters for each stage type are as follows:

Reals, separated  
by commas

Stage Type	Parameters
A	at, k, c, av
D	at, k, c, av
E	k, g, it, lt, w
G	sg, sg, sg, sg, sg
H	sh, sh, sh, sh, sh
J	none (card 12 omitted)
K	at, g, c, lt, f
L	sl, sl, sl, sl, sl
M	at, g, c, lt, f
N	sn, sn, sn, sn, sn
S	c, at, t, {p(t)}, {ts}
V	c, at, u {q(u)}, v, {r(v)},
Z	none (card 12 omitted)

Codes for parameters are:

- at = actual treatment time (when worker is with person or group--in standard time unit)
- av = worker's availability
- c = worker's wages
- f = fees paid/person
- g = number persons/group
- it = time interval between assignments
- k = number of workers
- lt = length of treatment
- {p(t)} = a set of 15 offense recidivism probabilities. These probabilities are for the time unit t. For Stage Type S, only 1 set of 15 probabilities are needed (accepts 80 cc of information). The numbers in parentheses on the table below indicate order in which recidivism probabilities will be expected.

Table 2 (cont'd)

Card Type Number  
or Order of Lines  
on Terminal

Definition

Format  
Restrictions

Codes continued:

Type of Offense	Number of Offenses in time t prob				
	0	1	2	3	4
Crashes	(1)	(2)	(3)	(4)	(5)
DWI Arrests	(6)	(7)	(8)	(9)	(10)
Violations	(11)	(12)	(13)	(14)	(15)

Zero probabilities are input for 0, 1, 2, 3, 4 offenses if a particular type of offense is not applicable (e.g., crashes are not of interest)

$\{q(u)\}$  = a set of 15 probabilities. This second set is only used with a stage Type V for during treatment probabilities.

$\{r(v)\}$  = a second set of 15 probabilities, placed on a separate card (unit record) and, as with the first set of probabilities, is preceded on the same card by the time unit v. These are the after treatment probabilities for a Stage Type V.

$s_g$  = Stage numbers, used with stage type G, to a maximum of 5 stages. They indicate the D- or E-type queues combined by the G-type stage.

$s_h$  = Stage numbers, used with stage type H, to a maximum of 5 stages. They indicate the A-type queues combined by the H-type stage.

$s_l$  = Stage numbers, used with stage type L, to a maximum of 5 stages. They indicate the K-type stages combined by the L-type stage.

$s_n$  = Stage numbers, used with stage type N, to a maximum of 5 stages. They indicate the M-type stages combined by the N-type stage.

Table 2 (cont'd)

Card Type Number  
or Order of Lines  
on Terminal

Definition

Format  
Restrictions

Codes continued:

t = time unit used with Stage Type S and is the time period (in standard time units) for which the recidivism probabilities are given.

u = time unit used with Stage Type V and is the time period for which the during treatment recidivism probabilities are given.

v = time unit used with Stage Type V and is the time period for which the after treatment recidivism probabilities are given.

{ts} = test scores: a set of 5 probabilities on a separate card (unit record)—third card for Stage V, second for Stage S. Test scores represent the probabilities of doing a certain percent better on the post-test than on the pre-test. Inputs are expected in the following sequence:

- (1) probability of doing 25% better;
- (2) probability of doing 20% better;
- (3) probability of doing 15% better;
- (4) probability of doing 10% better;
- (5) probability of doing 5% better.

If there are no test scores involved in a particular data file, there must be instead an input card which states "NO TEST SCORES" in ccl-14.

w = workload or number of groups per worker.

Table 2 (cont'd)

Card Type Number  
or Order of Lines  
on Terminal

Definition

Format  
Restrictions

Card 13-15 are re-  
peated for each  
flowpath of a  
single stage.

- |    |  |                                       |
|----|--|---------------------------------------|
| 13 | <u>Flowpath Name</u> : Name of stage to which this stage flows. This is a 12-character alpha field in columns 1-12. The rest of the card, ccl3-80 is free-read. If it is an exit stage, the name is EXIT.  | 3A4, cc 1-12,<br>ccl3-80<br>free-read |
| 14 | <u>Destination Stage Number</u> : Input is stage number of stage indicated by flowpath name of card type 13. For a stage name EXIT, zero is the stage number.  | Integer field<br>starting in<br>ccl   |
| 15 | <u>Branching Ratio</u> : (real number). If stage only flows to one other stage, branching ratio is 1.00. If stage flows to more than one stage, all flowpaths' branching ratios for one stage must add up to 1.00. If there are more than one grouping, there must be one branching ratio for each group, input in order of the group numbers and not separated by commas. The number of ratios for each stage must correspond to the number of groupings on Card 5. | Real number,<br>8F9.0                 |

Cards 13-15 are re-  
peated for each  
flowpath of a  
single stage.

- |    |  |        |
|----|--|--------|
| 16 | A <u>single asterisk</u> in cc 1 indicates the end of the stage's flowpaths. | *, c 1 |
|----|--|--------|

Cards 11-16 are re-  
peated for each  
stage.

Table 2 (cont'd)

Card Type Number or Order of Lines on Terminal	Definition	Format Restrictions
17	<u>4 asterisks</u> in cc 1-4 indicates the end of all stage input.	****, cc 1-4
18	<u>Dummy Stages:</u> This card indicates the number of dummy stages in the file (maximum of 10). Only stage types A, D, E, K, or M are acceptable.	I2, cc 1-2 right-justified
19	The next 2 cards are omitted if there are no dummy stages. a. Name of Stage b. Blank c. Type of Stage	3A4, cc 1-12 cc13 A1, cc14
20	Stage Parameters (see card 12 for correct format).	Reals, separated by commas cc 1-4
Cards 19 and 20 are repeated for each dummy stage.		
21	4 asterisks indicates end of dummy stages.	
22	<u>Reference Stage Number</u> for which arrival rate is given in next card.	Integer field starting in cc 1
23	<u>Arrival Rate:</u> People per standard time unit for reference stage 1. (Real number starting in cc 1). If there are more than one grouping there must be one arrival rate for each group. The number of groups must correspond to Card 5 and format is the same as card 15.	Real number starting in cc 1, 3F9.0

