VARIABLE SCHEDULE

MED-STATE NOTATION^{TM} PROCEDURE

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CHAPTER 1
Introduction

The purpose of this manual is to give an explanation of the MED State Notation™ Procedures that comprise the SOF-700RA-18 Variable Schedule Procedure. The files in this package can be found on the disk provided by MED Associates, Inc.

These procedures are intended to be run in MED Associates MED-PC® IV software. The latest version of MED-PC® IV gives researchers the ability to use pre-programmed procedures such as these to make hardware control and data collection easy. These pre-programmed procedures can also be modified to meet the evolving demands of a research protocol. Again, it is the intent of this manual to explain exactly what these procedures implement, and provide guidance into how to interpret what the program code achieves in order to let the user determine how to modify them to match their research protocol demands. The manual provides some examples of editing and modifying the procedure's programming code. The manual also defines the elements in the raw data file produced by these procedures.

In addition to this manual, refer to the **MED-PC® IV User's Manual** for the installation of the MED-Associates interface drivers, the MED-PC IV Software, and the Delphi® Compiler. Also refer to the User's Manual for instructions on developing a Hardware Configuration. Data file structure, file-saving format, and other related options are also determined by the Hardware Configuration. Running the Hardware Configuration software utility that accompanies MED-PC IV sets the Hardware Configuration. Its purpose is to assign the inputs and outputs on the interface cards in the interface cabinet for each task controlled by MED-PC IV. The particular type of interface card that is supplied in the interface cabinet may vary; please refer to the User's Manual provided for instructions on how to configure the type of card that is in the cabinet. A valid Hardware Configuration must exist in order for MED-PC IV to interface correctly with the MED Associates, Inc. hardware. This means that one should take the time to create a valid Hardware Configuration before attempting to run the procedures included in this package.

Should there be any problems, the staff at MED Associates, Inc. is available to answer any questions that may arise. Please e-mail us at support@med-associates.com with a detailed description of the problem or desired goals so that concise and detailed information may be provided.

The Variable Schedule procedure is designed to be as easy to use as possible. MED Associates, Inc. understands that researchers do not have the time to devote to programming and hardware design, and for that reason, we have undertaken that burden for you. We sincerely hope that you are satisfied with the products and services we provide, and look forward to meeting your future experimental needs as your research program evolves.

Overview of the Procedures

This is a Variable Schedule program written for MED-PC IV. Through a series of LIST statements the user may select between Fixed Ratio (FR), Fixed Interval (FI), Variable Ratio (VR), and Variable Interval (VI) Schedules to run. The LIST statements allow the user to select what the values for each Schedule type will be, how long each Schedule/Trial will run, how long the Interval between each Schedule/Trial is, and which Lever is the Correct Lever for that Trial by use of the Stimulus Location. The Correct Lever and the Stimulus Location must match.

For each Trial there is a PreCS and a CS period. The PreCS and CS period are always the same length. The correct response(s) on the Correct Lever during either period gives a reward. There is no reward given during the Inter-Trial Interval (ITI) or the Pre/Post Adapt periods. Any responses during the PreCS period are discarded when the CS period starts. So if the program is running an FR-10 schedule and the animal has 4 responses when the program switches to the CS period, the 4 responses are discarded and the animal must start over to meet the FR-10 schedule. The same schedule is run during the PreCS and CS periods (i.e. A VR-5 is run during the PreCS and then restarted during the CS period).

Control Variables

Variable Name	Default Value
Reward (1 = Pellet; 2 = Dipper; 3 = Drug)	1
Reward Time (seconds)	0.05
Number of Trials	10
Pre Adapt Period (seconds)	240
Post Adapt Period (seconds)	180

Program Example

The following is an example of how the LIST statements work using the default values in the program:

Trial 1:   S(0) = 1   =   Fixed Ratio
              T(0) = 4   =   Left Stim Light/Left Lever Correct
              U(0) = 60"   =   60 second PreCS/CS period
              V(0) = 180"   =   180 second ITI
              Z(0) = 1   =   FR-1 schedule

Trial 2:   S(1) = 2   =   Fixed Interval
              T(1) = 4   =   Left Stim Light/Left Lever Correct
              U(1) = 60"   =   60 second PreCS/CS period
              V(1) = 180"   =   180 second ITI
              Y(0) = 10"   =   FI-10 second schedule

Notice that Trial 1 uses Z(0) and Trial 2 uses Y(0). If Trial 3 were another FR schedule, then it would use the values in S(2), T(2), U(2), V(2), and Z(1). If Trial 4 was a VR schedule, then it would use the values in S(3), T(3), U(3), V(3), and a value(s) would be drawn randomly from LIST X.

The program will pull the value from each LIST in order. If the end of the LIST is reached, then it will start over from element 0 again. The only two exceptions is the Variable Ratio (X) and Variable Interval (W) LISTs. The values from those two LISTs will be drawn from randomly.

CHAPTER 2
Getting Started

Software Installation

Please refer to the **MED-PC IV User's Manual** for a complete guide to installing the MED-PC IV software, building a valid Hardware configuration with the Hardware Configuration utility, and opening and compiling a MSN procedure in the Trans-IV utility.

To install the Variable Schedule Procedure, insert the CD into the CD-ROM drive and click **Install the Variable Schedule Software**. The procedure is copied into the C:\MED-PC IV\MPC folder.

Backing Up the Software

Med Associates strongly encourages creating backup copies of the programs in case of disk failure. Having copies of the original programs may be useful in the future should modifications be made to the existing programs.

CHAPTER 3
Beginning & Running an Experiment

Translating the MED-PC IV (.mpc) File

Programs written in MedState Notation must be translated using Trans IV before they can be executed in this application. Be sure that a copy of the file being translated is present in the directory "C:\MED-PC IV\MPC\." Open Trans IV icon and select **Translation | Translate and Compile**.

Select the program(s) to use for the experiment and click **Make**. Click **OK** to start the translator, and it will automatically parse the MedState Notation and then open to a DOS screen to compile the Pascal code. Depending on the speed of the computer, each of these steps may not be seen. If any problems are encountered during this process, refer to the on-screen help menu or the **MED-PC Version IV User's Manual**, or contact MED Associates, Inc. for assistance.

Figure 3.1 - Trans IV Control Panel for Translating and Compiling MedState Notation Code
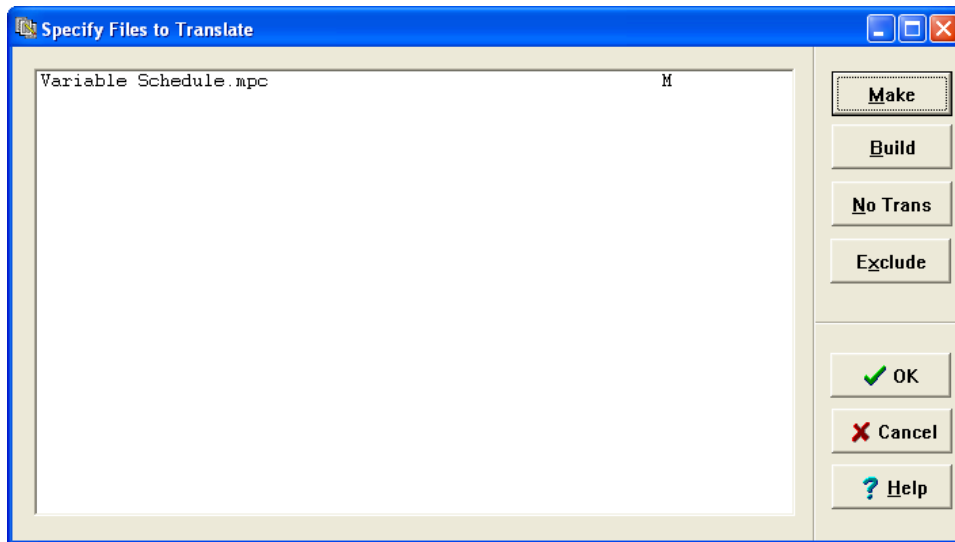
Using the MED-PC IV Load Wizard

MED-PC IV is designed to help the researcher run an experiment by guiding selection choices through its Experiment Loading Wizard. This section will describe how to initiate the Variable Schedule.mpc application, however the following steps that will also apply to all other .mpc procedures.

Open MED-PC IV and the MED-PC Experiment Loading Wizard's Welcome screen, shown in Figure 3.2 will appear.

Figure 3.2 - The MED-PC IV Loading Wizard Welcome Screen

To avoid this load wizard, deselect the checkbox labeled **Run this experiment automatically when starting MED-PC**. Close this screen by clicking the **Close** button. Closing this screen immediately reveals the MED-PC Run-Time Screen shown in Figure 3.9. If the choice to continue with the Loading Wizard is made, then click the **Next** button.

The Box Selection screen will appear next, as shown in Figure 3.3. From this screen the researcher chooses which boxes will be used in the experiment. Select the boxes that will run the experiment by clicking in the radio button next to the box number. The figure shows that the Hardware Configuration included only 1 box, which was selected. Click **Next** to continue.

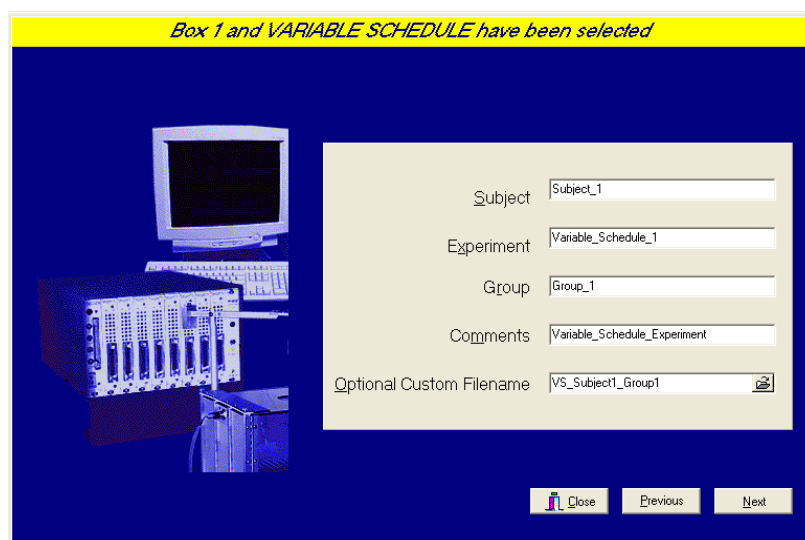*Figure 3.3 - The Box Selection Screen*

The Select a Procedure screen appears next, as seen in Figure 3.4. This is where the application to be run is selected. The screen displays a list of all the currently compiled procedures. Select the desired procedure and then click **Next**.

Figure 3.4 - The Select a Procedure Screen
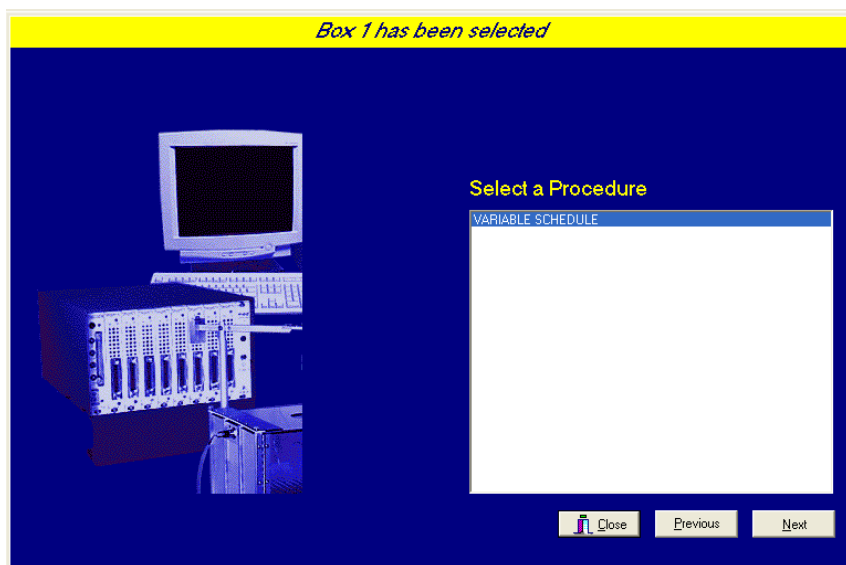
The Enter Experiment Data Screen should display next, as shown in Figure 3.5. The purpose of this screen is to allow annotations to be added to the data file that is produced by MED-PC IV. These annotations will help identify the Subject, Experiment, and Experiment Group upon which data was collected. Comments can be added here as well, and the data file can be given a customized file name to help identify it from other data files. Enter the information desired, and click **Next**.

Figure 3.5 - Enter Experiment Data Screen
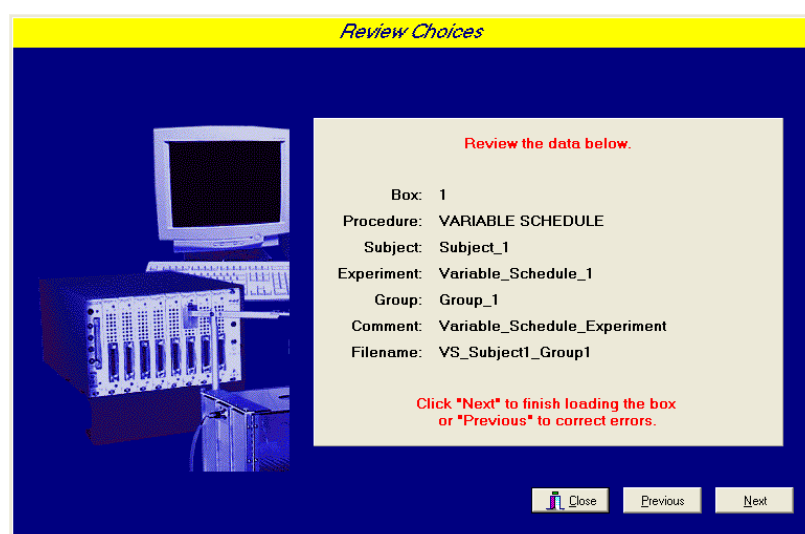
The next screen to appear is the Review Choices screen, as seen in Figure 3.6. This is a method of confirming that the information received from the Box/Procedure Selected is correct. If it is not correct, select **Previous**, and edit the data. If it is correct, select **Next**.

Figure 3.6 - Review Choices Screen

The Alter Session Parameters Screen, shown in Figure 3.7, is the next screen to appear, and is an important screen for the researcher.   The Alter Session Parameters screen allows the researcher to alter the parameters by which a procedure executes. The Send Start Command Screen appears next.   The options available on the screen vary depending upon how many boxes are described in the Hardware Configuration.

Figure 3.7 - Alter Session Parameters Screen

In this example only one box is described in the Hardware Configuration, so Figure 3.8 will appear next. If more than one box is in the Hardware Configuration, then Figure 3.9 will appear.

Figure 3.8 - Send Start Command Screen for Single Box Configuration

Figure 3.9 - Send Start Command Screen for Multiple Box Configuration
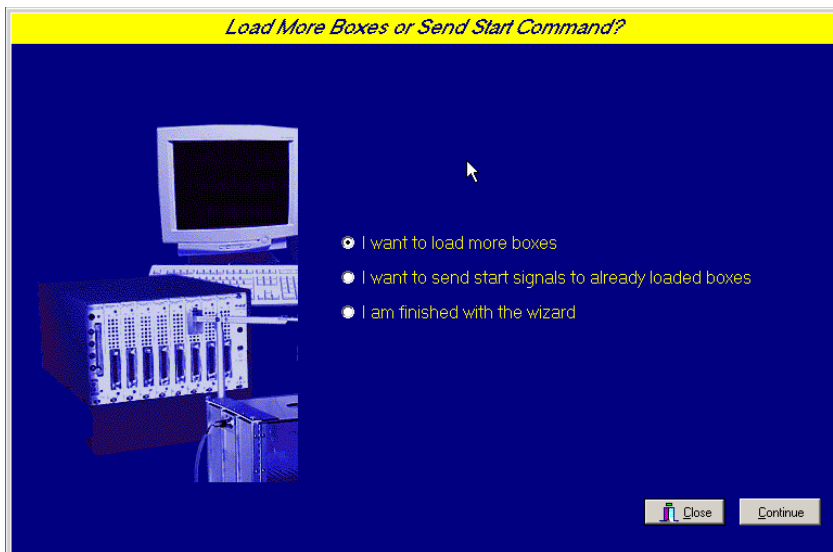
In both cases (Figure 3.8 and Figure 3.9), the screens are where the researcher decides to either load more boxes, send a start signal to boxes that are already loaded, or enter the MED-PC IV run-time environment without sending a start signal by selecting "I am finished with the wizard". This option results in the screen shown in Figure 3.10.

Figure 3.10 - The MED-PC IV Run-Time Screen
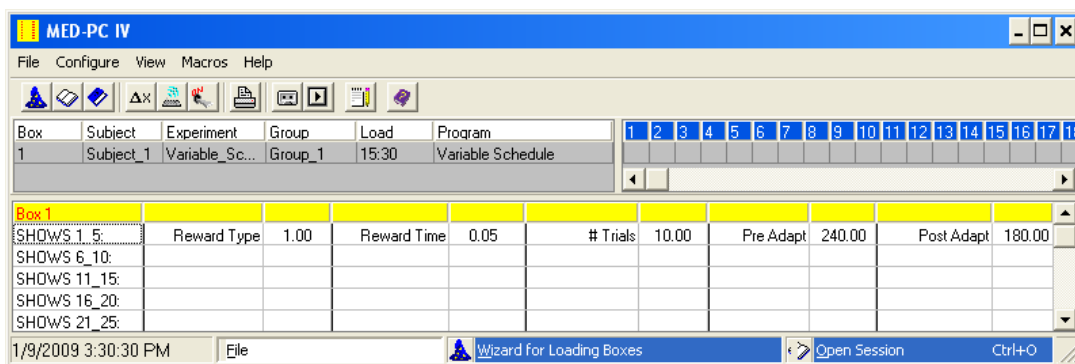
Viewing/Changing Variable Values

Before a "start command" has been issued, any variable may be changed on the MED-PC IV run-time screen. Simply highlight the value to change, and then enter the new value. Once a session is in progress, change variables by selecting **Configure | Change Variables**, or click the 4th tool bar item **ΔX**. In the lower left hand corner of the Change Variables window, find the "Display Data from Box" display, and choose the chamber(s) to modify.   By clicking additional boxes in the "Additional Boxes to Update" section, changes made to a single box are automatically loaded to all of the selected boxes.

Figure 3.11 - Changing Variables Screen

The value of any simple variable may be viewed from this screen by clicking an array on the table and each element in that array can be viewed, as shown in Figure 3.12. To change a value, simply highlight and replace the value in the lower right hand box or use the up/down arrows to increment by 1. Click the **Issue** button for the change to take effect. Click **Named Variables** to produce the display in Figure 3.13. Change variables here as needed.

Figure 3.12 - Displaying Array A from Box 1

Figure 3.13 - Displaying Named Variables from Box 1

Macros

The simplest way to initially create a macro is to record keyboard functions while performing the steps manually. Once the commands are in the macro, it is easy to create a number of macros with the macro editor. The following example illustrates the process of loading "Box 1" and changing the Number of Trials to 20.

To begin, open MED-PC IV and going directly to the run time screen. Close the load wizard, if present. Before loading or opening the procedure, click **Macro** on the main menu and select **Turn On Macro Recorder** or click the 8th tool bar item with the cassette tape icon on top. A note on the bottom of the display indicates that the recorder is running. Open "Variable Schedule.mpc" by clicking **Files | Open Session**. Change the variables using any of the methods described above. When all settings have been made, turn the recorder off again by using the main menu or tool bar. Save the macro with a distinctive name. The example in Figure 3.14 was named "VS_20Trials.mac" since the Number of Trials was changed to 20.

Figure 3.14 – VS_20Trials.mac
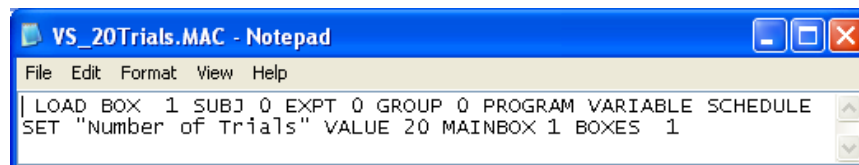
Once this macro is built, use the macro editor to make simple changes such as replacing reward or correct lever values. Review the Help file on screen or the **MED-PC IV User's Manual** for more information on macros and the features offered. A START command or message box followed by a START command could be added to the macro (it was left off here so changes could be verified before starting the procedure).

Modifying the MedState Notation^{TM} Code

Permanent changes to the Variable Schedule procedure can be made to the MedState Notation code. To make the same change to the Number of Trials to 20 as shown above, do the following. Open Trans IV and select **File | Open** to place Variable Schedule.mpc into the text editor. Scroll down to approximately line 196 (note the line counter in the lower right hand corner of the editor) to reveal the code shown in Figure 3.15.

Figure 3.15 – Variable Schedule.mpc Line 196
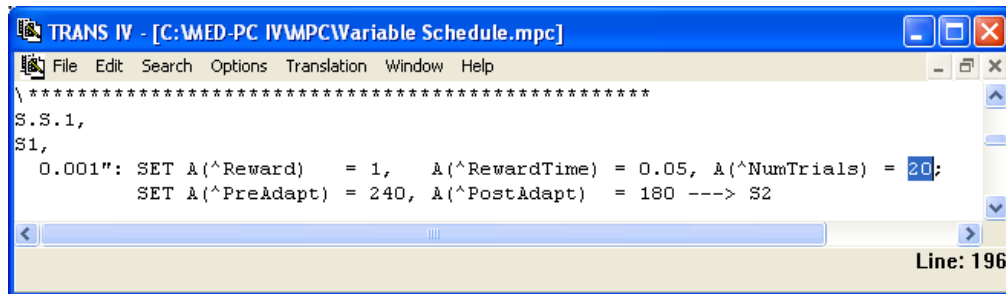
Change A(^NumTrials) =10 to A(^NumTrials) =20 and save the changes with the same or a new file name such as VS_20Trials.mpc. Remember, if creating a new .mpc file name and are using a macro to load boxes, the file name in the macro also must be changed. Translate and compile the new or changed file as described previously and run MED-PC IV. Use the "Change Variables" screen to view/confirm the new values.

CHAPTER 4

Understanding the Data Files

Unless otherwise specified, data will be saved to C:\MED-PC IV\DATA. Data can be saved manually by selecting **FILE | SAVE DATA MANUALLY** or **FILE | SAVE DATA (FLUSH)**. The file name that is used to save the data in depends on the option that was chosen in the Hardware Configuration Utility and may also be dependent on the Subject, Experiment, and Group name provided in the MED-PC IV load wizard. Within each data file, the headings are created for each Subject, Experiment, Group, Box, etc., (see below). Data files may be opened with note pad, word pad, or any word processor or spreadsheet; however, be sure they are always saved "unformatted" in case a data extraction utility such as MED-PC to Excel might ever be used. Data file formats are explained in detail in the **MED-PC IV User's Manual**.

Sample Data File

Select **Annotated** on the file options page during hardware installation to produce a raw data file similar to the following. Data files are located in C:\MED-PC IV\Data\ unless an alternate path was defined during hardware installation. They may be opened with note pad, word pad, or any word processor; however, make sure they are always saved <u>unformatted</u> in the occasion a data extraction utility such as MPC2XL is used. The header information should be self-explanatory. Data-file formats are explained in detail in the **MED-PC IV User's Manual**.

File: C:\MED-PC IV\DATA\!2009-01-09

```
Start Date: 01/09/09
End Date: 01/09/09
Subject: 0
Experiment: 0
Group: 0
Box: 1
Start Time: 15:53:24
End Time: 16:58:12
MSN: Variable Schedule
C:        0.000
D:        5.000
E:     3240.000
F:        0.000
G:     6000.000
H:      500.000
I:        2.000
J:       10.000
K:       10.000
L:        9.000
M:        0.000
N:        0.000
O:        3.000
P:        3.000
Q:       60.000
R:       10.000

A:
      0:       1.000       5.000      10.000   24000.000   18000.000
```

```
B:
   0:       259.000      174.000       85.000       67.181       32.819       81.000
   6:         1.000        1.000       11.000        3.000        3.000        3.000
  12:         2.000        2.000        0.000        1.000        4.000        5.000
  18:         3.000        3.000       13.000        3.000       18.000        2.000
  24:         4.000        4.000        5.000        5.000        6.000        8.000
  30:         5.000        1.000       18.000        8.000       12.000        3.000
  36:         6.000        2.000        3.000        2.000        4.000        3.000
  42:         7.000        3.000        5.000        3.000       26.000        7.000
  48:         8.000        4.000        2.000        3.000        6.000        9.000
  54:         9.000        1.000        8.000        7.000       18.000        0.000
  60:        10.000        2.000        4.000        6.000        8.000        4.000
S:
   0:         1.000        2.000        3.000        4.000
T:
   0:         4.000        5.000        4.000        5.000        4.000        5.000
   6:         4.000        5.000        4.000        5.000
U:
   0:      6000.000     6000.000     6000.000     6000.000     6000.000     6000.000
   6:      6000.000     6000.000     6000.000     6000.000
V:
   0:     18000.000    18000.000    18000.000    18000.000    18000.000    18000.000
   6:     18000.000    18000.000    18000.000
W:
   0:       300.000      500.000      700.000      900.000     1000.000
X:
   0:         1.000        3.000        5.000        7.000       10.000
Y:
   0:       300.000      700.000      500.000      900.000     1000.000
Z:
   0:         1.000        3.000        5.000        7.000       10.000
```

Breakdown of Sample File - Simple Variables

The following simple variables are shown immediately following the header information:

```
C:         0.000      Ratio Counter
D:         5.000      Value Drawn from List
E:      3240.000      Elapsed Time in Session
F:         0.000      Not Used
G:      6000.000      Value Drawn from List
H:       500.000      Value Drawn from List
I:         2.000      Index Into Trial Types Array S
J:        10.000      Index Into Stimulus Location Array T
K:        10.000      Index Into Stimulus Duration Array U
L:         9.000      Index Into Inter-Trial Interval Values Array V
M:         0.000      Not Used
N:         0.000      Not Used
O:         3.000      Index Into Fixed Interval Array Y
P:         3.000      Index Into Fixed Ratio Array Z
Q:        60.000      Index Into Trial by Trial Data Array B
R:        10.000      Trial Counter
```

Breakdown of Sample File - Arrays

The arrays are presented in rows of 6 elements each. The first row begins with element 0 and ends with element 5; the second row begins with element 6 and ends with element 11, etc. Each row begins with an element marker followed by a colon, 0:, 6:,12:, 18:, 24:, etc.   Size of Array B was set to 10000 with the DIM command, which means that Array B was defined for 10001 data points. Under MED-PC Version IV, this array may be enlarged up to 1 million elements; however, 10,000 was felt to be adequate for this application. An end of array seal -987.987 will limit the saved file to only those elements used during the running of the procedure.

Each array has been defined in the comments section at the beginning of the .mpc file. That information was used to add the following labels to each array. The lines were expanded to make room for the labels. Refer to the MPC2XL User's Manual for producing labeled data files with all or just some of the information below.

Array A

Array A contains the control variable values. The values are preset to default values in State Set 1, State 1. They are displayed as named variables and can be changed by any of the methods described previously. Once a session is started these values should not be changed to ensure the integrity of the experiment.

Row Marker	A(0) Reward (Pellet = 1; Dipper = 2; Drug = 3)	A(1) Reward Time in MED Ticks	A(2) Number of Trials	A(3) Pre Adapt Period in MED Ticks	A(4) Post Adapt Period in MED Ticks
0:	1.000	5.000	10.000	24000.000	18000.000

Array B

Array B contains the trial data. Elements B(0) through B(5) contain the session data. Elements for Total Responses, Total Correct Responses and Incorrect Response will be incremented according to animal's responses as session runs. The Final Total Percent Correct, Final Total Percent Incorrect and Final Total Rewards are calculated when the trial is completed. Elements B(Q) through B(Q+5) contain the trial data.

Row Marker	B(0) Total Responses	B(1) Total Correct Responses	B(2) Total Incorrect Responses	B(3) Final Total % Correct	B(4) Final Total % Incorrect	B(5) Final Total Rewards
0:	259.000	174.000	85.000	67.181	32.819	81.000

	B(Q) Trial Number	B(Q+1) Trial Type (1=FR; 2=FI; 3=VR; 4=VI)	B(Q+2) PreCS Correct Responses	B(Q+3) PreCS Incorrect Responses	B(Q+4) CS Correct Responses	B(Q+5) CS Incorrect Responses
6:	1.000	1.000	11.000	3.000	3.000	3.000
12:	2.000	2.000	0.000	1.000	4.000	5.000
18:	3.000	3.000	13.000	3.000	18.000	2.000
24:	4.000	4.000	5.000	5.000	6.000	8.000
30:	5.000	1.000	18.000	8.000	12.000	3.000
36:	6.000	2.000	3.000	2.000	4.000	3.000
42:	7.000	3.000	5.000	3.000	26.000	7.000
48:	8.000	4.000	2.000	3.000	6.000	9.000
54:	9.000	1.000	8.000	7.000	18.000	0.000
60:	10.000	2.000	4.000	6.000	8.000	4.000

Array S

Array S contains the list of trial types to be run. 1 = Fixed Ratio, 2 = Fixed Interval, 3 = Variable Ratio and 4 = Variable Interval.

```
S:
    0:            1.000        2.000        3.000        4.000
```

Array T

Array T contains the list of stimulus locations for each trial, 4 = Left Light and 5 = Right Light if the hardware is connected as recommended in the program.

```
T:
    0:            4.000        5.000        4.000        5.000        4.000        5.000
    6:            4.000        5.000        4.000        5.000
```

Array U

Array U contains the list of stimulus durations (in MED Ticks or 0.01 second intervals) for each trial.

```
U:
    0:         6000.000     6000.000     6000.000     6000.000     6000.000     6000.000
    6:         6000.000     6000.000     6000.000     6000.000
```

Array V

Array V contains the list of Inter-Trial Interval values (in MED Ticks or 0.01 second intervals) for each trial.

```
V:
    0:        18000.000    18000.000    18000.000    18000.000    18000.000    18000.000
    6:        18000.000    18000.000    18000.000
```

Array W

Array W contains the list of Variable Interval values (in MED Ticks or 0.01 second intervals).

```
W:
    0:          300.000      500.000      700.000      900.000     1000.000
```

Array X

Array X contains the list of Variable Ratio Values.

```
X:
    0:            1.000        3.000        5.000        7.000       10.000
```

Array Y

Array Y contains the list of Fixed Interval Values (in MED Ticks or 0.01 second intervals).

```
Y:
    0:      300.000       700.000       500.000       900.000      1000.000
```

Array Z

Array Z contains the list of Fixed Ratio values.

```
Z:
    0:        1.000         3.000         5.000         7.000        10.000
```