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DECISION SUPPORT SOFTWARE

*Pinney McWilliams Atchison*



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DECISION SUPPORT SOFTWARE

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## **PREFACE**

As the power, speed, and storage capacity of the personal computer (PC), and its acceptance as an indispensable tool for students in Business Administration have increased in recent years, and with the availability of PC labs on most campuses, computer packages which support courses in Management Science, Quantitative Methods, Decision Sciences, and Production/Operations Management have become available.

These software packages allow consideration of problems beyond the size and scope of those traditionally solved “by hand” in textbook examples, and provide sensitivity (post optimality) analysis for many of the models, not fully covered in some texts. DECISION SUPPORT SOFTWARE (DSS) provides support for these courses with a collection of 22 models designed with the following features:

- Completely MENU DRIVEN operation.
- Context-specific ONLINE MANUAL throughout.
- On-screen STATUS BAR to prompt the user.
- DIALOG BOXES allowing the user to specify desired options.
- ALERT BOXES for errors or warnings.
- Student-friendly (low-tech) MANUAL, with explicit numerical EXAMPLES for every module, and INPUT and OUTPUT displayed ON SCREEN and in the manual.
- GRAPHICAL output for most modules.
- END OF CHAPTER problems, with SOLUTIONS in the Appendix.
- Ease of EDITING/UPDATING/MODIFYING existing problems.
- Ability to custom EDIT with a WORD PROCESSING package.

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Special mention must go to DeVilla Williams, Laura Elligson, Mike Hanna, Faizul Huq, and Martin Starr for their insightful comments and helpful suggestions.

Work is continuing on enhancements for the DSS package, with a version that takes full advantage of the popular Graphical User Interface (GUI) utilities available on the market. In addition, there are plans to add models typically associated with the Production/Operations Management (P/OM) area, such as Materials Requirement Planning (MRP) and Assembly Line Balancing.

Finally, the authors assume responsibility for any errors which may be found in the text or the software, and would welcome any suggestions for correction or improvement in the DSS package.

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# INTRODUCTION

Welcome to **DECISION SUPPORT SOFTWARE (DSS)**! This introduction describes the hardware and software requirements, discusses the overall conventions and assumptions, explains the installation and startup procedures, and acquaints the user with the major features of DSS.

This manual also contains chapters on each of the models in DSS, which lead the user through the detailed operation of each model, in the context of specific numerical examples. There are practice problem sets at the end of each chapter, with solutions presented in the Appendix.

The attempt throughout is to *communicate* with the user, rather than to confuse or impress, as is the case with so many “users’ manuals.” The context-sensitive help screens throughout the software give specific guidance to the use of the models, and the on-screen help line or status bar prompts the user as to the expectations and options at the present moment.

While some background of the types of problems that can be solved by each of the models is presented in this manual, it is assumed that the user has a reasonable working knowledge of the models. Those unfamiliar with the solution procedures should use DSS along with a “Quantitative Methods for Management” text that explains the theory and limitations of each of the models.

Experienced users should have little to no problem in entering problems and understanding the outputs. All suggestions for improvements in the user/model interface will be gratefully received and considered for incorporation in future releases of the software.

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## NOTATIONAL CONVENTIONS

Characters appearing within the “<” and “>” symbols indicate a key or key combination that DSS requires to carry out some operation. Keys that have no mnemonic will be referred to by their popular name, as in <SPACEBAR> for the large horizontal key located at the bottom center of the typewriter portion of the keyboard. Key combinations, indicated with a plus symbol (+), should be pressed concurrently to obtain the desired effect. For example, <ALT+I> means that the “Alt” key and the “I” key should be depressed and released simultaneously.

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## SYSTEM REQUIREMENTS

### Hardware

DSS requires at least an IBM PC-XT class of machine with two floppy drives, a monochrome monitor, 384K bytes of random access memory (RAM), and an 84-key keyboard. It has been certified to run on any 100% IBM PC compatible in the 80x86 Intel processor family. The recommended configuration is at least an 80286 IBM PC-AT class machine with a hard drive, EGA monitor, 640K RAM and a printer.

When you start DSS, it detects the capabilities of the equipment on which it is running and automatically tailors itself to provide the highest level of functionality for that equipment. If it detects that a monochrome monitor is in use, it will set highlight levels accordingly, disable color options, and disable the graphic output of the problem solutions. If a CGA monitor is in use, problem solutions may be viewed in low resolution color graphics output. If an EGA or higher monitor is attached, solutions will be graphed in high resolution color. If it detects that it is being run from a floppy drive, it will require a two-drive configuration, with one of the drives for its programs and the other drive for your problem files.

### Software

DSS will not execute under DOS version 2.0 or lower. It has been certified on all higher releases of DOS, as a DOS application under Windows, and as a DOS application in an OS/2 DOS compatibility box. For running under Windows, the Program Information File (PIF) should be set for maximum available conventional memory. Also note that graphics output will not be available unless DSS is run as a full screen application. Future releases are planned for the Windows, Macintosh, and UNIX environments. There are no plans at this time to release the software as a native OS/2 application.

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## SYSTEM CONSTRAINTS

### Problem Sizes

Exhibit INTRO.1 shows the upper constraints of the problem sizes.

### Memory Constraints

All non-graphic DSS generated output is directed to a special system file, LASTRUN.S. When you view a solution, you are actually browsing the contents of this generated file. The size of this file can get quite large, both vertically and horizontally, so there may not be enough memory to view the entire output. DSS will load and display as much of the solution as it can, and will inform you if it cannot display the entire solution file. In these rare cases, you may want to exit DSS and use any good text editor or word processor package to view the entire solution by opening the file "LASTRUN.S" (or the filename you specified, if you saved the solution). Alternatively, printing the solution will always print the entire solution file.



Module	Maximum Problem Size	Maximum Graph Size
Linear Programming	50 Variables $\times$ 50 Constraints	2 variables $\times$ 8 constraints, scale of 1000
Integer Programming	25 Variables $\times$ 24 Constraints, 50 Branches	2 variables $\times$ 8 constraints, scale of 1000
Assignment	25 Rows $\times$ 25 Cols	12 $\times$ 12
Transportation	25 Destinations $\times$ 25 Sources	12 $\times$ 12
Networks		
CPM/Pert	25 Activities	20 Activities
Max Flow/Min Cut	25 Nodes	25 Nodes
Min Span Tree	25 Nodes	25 Nodes
Shortest Path	25 Segments	20 Segments
Traveling Salesrep	25 Cities	25 Cities (Box Canyons not displayed)
Forecasting		
Averaging	60 Periods	25 Periods
Regression	60 Observations	25 Observations
Inventory & Production	n/a - fixed input	n/a - fixed input
Dynamic Programming		
Knapsack	25 Items	25 Items
Stagecoach	25 States	25 States
Production Planning	25 Periods	12 Periods
Decision Analysis	25 Outcomes $\times$ 25 Actions	No Graphical output
Queues	n/a - fixed input	n/a - fixed input
Markov	25 Entities	8 Entities
Simulation	1440 Periods	30 Periods

#### Exhibit INTRO.1 DSS problem dimensions for each module

### INSTALLATION INSTRUCTIONS

DSS is shrink-wrapped as a ready-to-use application and requires no installation when used from a floppy drive. If DSS is to be used from a hard drive, an installation program is included on DSS Disk #1. To install DSS on your hard drive, insert Disk #1 in the floppy drive and type

a: (or b:)                      To make the floppy drive the active drive.  
install                          To start the installation program.

The installation program will guide you through selection of the source drive, the target hard drive, and the target directory on the hard drive. The default values will install DSS from the a: drive to the c:\DSS subdirectory.

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## STARTUP

### Local Hard Drive

DSS must be run from the directory on which it resides. This is accomplished by making the DSS directory the current directory and then running the DSS executable module. The typical set of DOS commands to make DSS the current directory and to start the program is

c:	To make "c" the current drive.
cd\dss	To make "dss" the current directory.
dss	To run DSS.

This assumes that DSS was installed on the "C" drive in the "DSS" directory. Please note that DSS will use this directory exclusively; that is, it will use this directory to store problem and solution files.

### Floppy Drive

The DOS commands to run DSS from a floppy drive are

a: (or b:)	To make "a" (or "b") the current drive.
dss	To execute DSS.

where program diskette #1 is placed in the "a" (or "b") drive.

### Network Drive

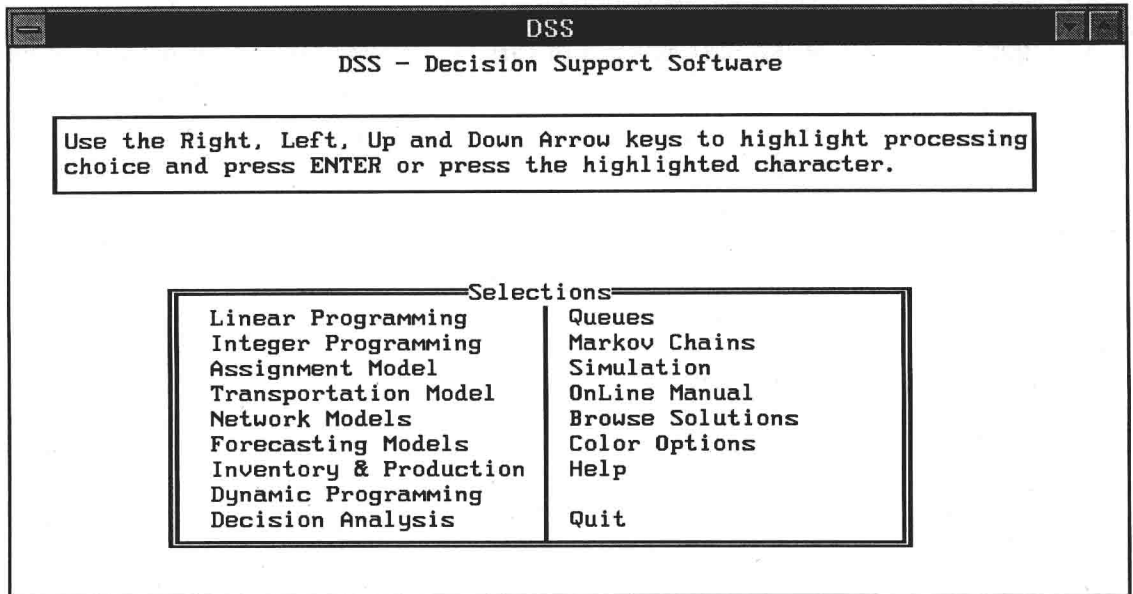
If DSS is to be installed on a network, a site license agreement is required. Please contact the publisher for the specific requirements for such an agreement. DSS will operate from a network drive as it would from any other hard drive. When used in this fashion, it will expect to locate all problem and solution files on the directory on which it has been installed. However, it is expected that at most educational institutions the students' work will not be stored on network drives. DSS will accommodate this need by its ability to store problem and solution files on either the "a" or "b" drives. The following DOS commands typify the startup sequence for DSS from a network drive (or local hard drive) when it is desired to use a floppy drive for storing students' work.

g:	To make "g" the current drive.
cd\dss	To make "dss" the current directory.
dss a	To run DSS and direct file output to the "a" drive.

The preceding example assumes that DSS was installed on the "g" drive in the "dss" directory and that the output will be directed to the "a" drive. It is recommended that the network system administrator authorize students for read-only access on the DSS directory and that a batch execution file be set up to automate this system startup process.

### Main Menu

If you have followed the installation procedure for your hardware configuration, you should be presented with the main DSS menu shown in Exhibit INTRO.2.



**Exhibit INTRO.2    Main DSS menu**

## USER INTERFACE CONVENTIONS

### Keyboard

Special care has been taken to make the user/machine interface of DSS as intuitive and easy-to-learn as possible. Toward that end, the user can expect each of the modules to behave in a manner consistent with all of the other modules. In addition, the active control keys are displayed at all times during problem creation, editing, and solution browsing. This section illustrates the keyboard conventions and details the usage of the keys.

**<SPACEBAR>** Used as a toggle key for those data input fields that only allow a small number of valid responses.

**<ENTER>** Accepts an entry.

**<END>** Has several uses, depending on the location in the system. In navigating the menus, <END> can be used to back up one menu or return to the previous menu. During problem input, <END> indicates that the user is finished inputting a class of variable. If <END> is pressed while inputting the last class of variable, it indicates that the user has finished entering or editing the problem. When <END> is pressed while viewing a solution, it indicates that the user is finished viewing the problem and wishes to return to the problem menu.

**<INS>** Toggles between "INSERT" and "OVERWRITE" modes.

<HOME> During problem entry/edit, <HOME> is a quick way of moving the highlight to the first occurrence of the current class of variable. When <HOME> is pressed while viewing a solution, it moves the display to the upper left boundary of the solution.

<ESC> Is used in one of four ways: (1) to clear an error box, (2) to abort entering or editing a problem without being given the opportunity to save the problem, (3) to abort a solution in progress, and (4) to exit the system. The first three uses are dependent on the current operational mode of the system. The fourth use is effective everywhere else.

<UP> The up arrow key (which may be labeled on the keyboard as "↑") is used on the vertical menus to move the highlight bar up one selection per key press. If the highlight bar is at the top, the highlight jumps to the bottom of the menu. On the problem entry/edit screens, <UP> is used to move the highlighted cell up one cell per key press. If the highlighted cell is at the top of the problem, the highlight jumps to the bottom of the problem. While viewing a problem solution, <UP> scrolls the output up one line per key press. If <UP> is pressed while at the top of a solution, the status bar will indicate that the upper boundary has been reached and the key press will have no effect on the solution display.

<DOWN> The down arrow key (which may be labeled on the keyboard as "↓") is used on the vertical menus to move the highlight bar down one selection per key press. If the highlight bar is at the bottom, the highlight jumps to the top of the menu. On the problem entry/edit screens, <DOWN> is used to move the highlighted cell down one cell per key press. If the highlighted cell is at the bottom of the problem, the highlight jumps to the top of the problem. While viewing a problem solution, <DOWN> scrolls the output down one line per key press. If <DOWN> is pressed while at the bottom of a solution, the status bar will indicate that the lower boundary has been reached and the key press will have no effect on the solution display.

<RIGHT> The right arrow key (which may be labeled on the keyboard as "→") is used on the horizontal menus to move the highlight bar to the right one selection per key press. If the highlight bar is at the right edge, the highlight jumps to the left edge of the menu. On the problem entry/edit screens, <RIGHT> is used to move the highlighted cell right one cell per key press. If the highlighted cell is at the right boundary of the problem, the highlight jumps to the left boundary of the problem. While viewing a problem solution, <RIGHT> scrolls the output right one column per key press. If <RIGHT> is pressed while at the right boundary of a solution, the status bar will indicate that the right boundary has been reached and the key press will have no effect on the solution display.

<LEFT> The left arrow key (which may be labeled on the keyboard as "←") is used on the horizontal menus to move the highlight bar to the left one selection per key press. If the highlight bar is at the left edge, the highlight jumps to the right edge of the menu. On the problem entry/edit screens, <LEFT> is used to move the highlighted cell left one cell per key press. If the highlighted cell is at the left boundary of the problem, the highlight jumps to the right boundary of the problem. While viewing a problem solution, <LEFT> scrolls the output left one column per key press. If <LEFT> is pressed while at the left boundary of a solution, the status bar will indicate that the left boundary has been reached and the key press will have no effect on the solution display.

**<PGUP>** The page up key (which may be labeled on the keyboard as “Pg Up” or “Page Up”) is used on the problem solution screen to scroll the output up one page (22 lines) per key press. If <PGUP> is pressed while at the top of a solution, the status bar will indicate that the upper boundary has been reached and the key press will have no effect on the solution display.

**<PGDN>** The page down key (which may be labeled on the keyboard as “Pg Dn” or “Page Down”) is used on the problem solution screen to scroll the output down one page (22 lines) per key press. If <PGDN> is pressed while at the bottom of a solution, the status bar will indicate that the lower boundary has been reached and the key press will have no effect on the solution display.

**<TAB>** The forward tab key (which is labeled on the keyboard as “Tab”) is used on the problem solution screen to scroll the output to the right one page (80 columns) per key press. If <TAB> is pressed while at the right boundary of a solution, the status bar will indicate that the right boundary has been reached and the key press will have no effect on the solution display.

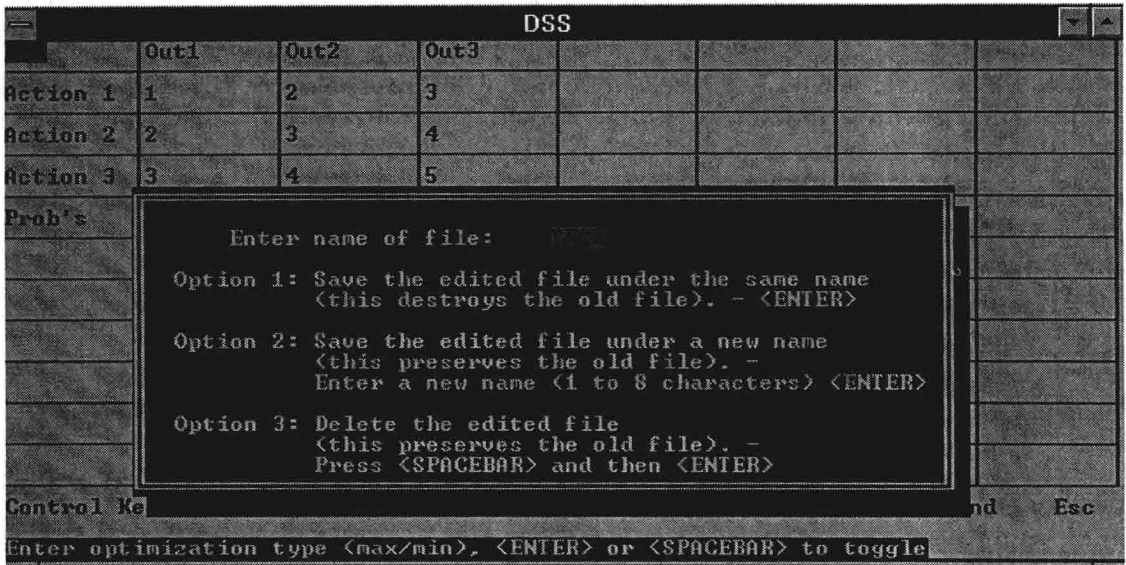
**<BACKTAB>** The back tab key (which is also labeled on the keyboard as “Tab” but is the shifted value) is used on the problem solution screen to scroll the output to the left one page (80 columns) per key press. If <BACKTAB> is pressed while at the left boundary of a solution, the status bar will indicate that the left boundary has been reached and the key press will have no effect on the solution display.

**<ALT+I>** The <ALT+I> key combination, which is the simultaneous striking of the “Alt” key and the “I” key, is used to insert a new row or column into a problem, where applicable. To insert a new row, <ALT+I> should be pressed while the highlight is in the first column of the problem. Depending upon the module being edited, the currently highlighted row and all rows below will be shifted down and a blank row will appear in the place of the highlight, or the new row will appear below the current bottom row. To insert a new column, <ALT+I> should be pressed while the highlight is in the first row of the column, or in the body of the input data matrix. Depending upon the module being edited, the currently highlighted column and all columns to the right will be shifted right and a blank column will appear in the place of the highlight, or the new column will appear to the right of the last column.

**<ALT+D>** The <ALT+D> key combination, which is the simultaneous striking of the “Alt” key and the “D” key, is used to delete a row or column from a problem, where applicable. To delete a row, <ALT+D> should be pressed while the highlight is in the first column of the problem. The currently highlighted row will disappear and all rows below will be shifted up. To delete a column, <ALT+D> should be pressed while the highlight is in the first row of the column, or in the body of the data input matrix. The currently highlighted column will disappear and all columns to the right will be shifted left.

## Dialog Boxes

DSS uses pop-up dialog boxes to gather information from the user that is relative to the operation being performed. Exhibit INTRO.3 shows an example of a dialog box that is prompting for filename input. Other uses of the dialog boxes are to dimension a data



### Exhibit INTRO.3 Dialog box for file saving options

input matrix, to specify solution options, to print or save a solution, to define printer parameters, and to confirm a request.

### Status Bar

The bottom-most line of the screen contains a status bar that displays helpful hints and information that is pertinent to the operation currently being performed. The status bar also displays warning messages (accompanied by an alarm) for minor errors; for example, entering a decimal point when an integer is required.

### Alert Box

The alert box is a special pop-up dialog box that appears when a more serious error has occurred or when user intervention is required. For instance, an alert box appears when print has been requested but the printer is not available, or when an operation tries to use more memory than is available. The only valid keyboard response to an alert box is <ESC>.

### Problem and Solution Files

DSS allows the user to name problem and solution files with any valid 1 to 8 character name. Exhibit INTRO.3 shows the "Enter File Name" dialog box. It does not allow the use of any non-alphanumeric characters in the filename. DSS uses the DOS filename extension to distinguish among the different problem types and to differentiate problem files from solution files.

For example, if you input a linear programming problem and save it under the name "sample," the system will actually save it under the DOS filename "sample.p5." If you subsequently solve the problem and save the solution, the system will prompt you for a filename, but will default the name to "sample." If you save it under the name "sample," DSS generates the extension "s5" and saves the file under the DOS filename "sample.s5." The "5" is an index number that indicates the problem type is linear programming, and the "p" and "s" indicate problem files and solution files, respectively.

Ordinarily, you do not need to be aware of these "behind the scenes" activities; however, if you wish to open a solution file by a word processing package or generate a problem file in a spreadsheet package, it will be necessary to know the complete filename. Exhibit INTRO.4 details the problem type index numbers. As noted under the memory constraint section above, all solutions are written to a file named "LASTRUN.S," and this file may also be opened by a word processing package as a text-only ASCII file.

---

Problem Type	Index
Markov	2
Linear Programming	5
Assignment	8
Transportation	11
Network Models	
CPM/Pert	15
Min Spanning	18
Shortest Path	21
Max Flow	24
Traveling Salesman	27
Forecasting	
Averaging	31
Linear Regression	34
Dynamic Programming	
Knapsack	47
Stagecoach	50
Production Planning	53
Inventory & Production	
EOQ / Discounts	60
Production Lot Size	63
EOQ / Stockouts	66
Decision Analysis	69
Queueing	76
Integer Programming	82
Simulation	
Queueing	86
Inventory/Production	89

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## Menu Navigation

Menu selections may be made by either pressing <ENTER> while the desired selection is highlighted or by pressing the highlighted character in the desired selection. The highlight bar can be moved by using the arrow keys. <F1> will display a help screen whose contents correspond to the menu currently displayed. <ESC> allows the user to quit or exit DSS. <END> moves to the previous menu or allows the user to exit DSS if pressed while viewing the main menu.

All problem menus have the selections "CREATE EDIT SOLVE GRAPH PRINT DELETE RETURN HELP QUIT," in addition to a scrollable list window that displays all of the previously saved problem files of that particular problem type. CREATE is selected to enter a new problem. EDIT, SOLVE, GRAPH, PRINT, and DELETE operate in conjunction with the currently highlighted problem filename. EDIT is used to view and modify an existing problem. SOLVE is selected to generate the solution to a problem. GRAPH will generate a solution and plot a graphic representation of that solution. PRINT prints the problem itself, not the solution. DELETE is used to erase a problem file from the disk. RETURN invokes the previous menu, HELP calls up a context-sensitive pop-up help window, and QUIT is used to exit the system. These commands may be invoked by highlighting their names using the arrow keys and pressing <ENTER>, or by pressing their first letters (C, E, S, G, P, D, R, H, or Q).

## Problem Navigation

While creating a new problem, DSS will lead the user through most of the problem entry through the use of <ENTER>. <END> is used to indicate that the entry of a class of variable is finished. All problems in DSS are either in a spreadsheet format or a fixed format. The spreadsheet format is characterized by a variable number of rows and/or columns, as in the Markov, Linear Programming, and Assignment modules. The fixed format contains a set number of input parameters, as in the Queueing, Inventory & Production, and Simulation modules. Spreadsheet format problems must be "sized" before the data input matrix is displayed. This is accomplished through the use of a dialog box which is displayed when the user selects CREATE. The arrow keys are used to move the highlight in the data matrix. <ESC> allows the user to exit the CREATE or EDIT modes immediately without saving the problem. <HOME> moves the highlight to the first occurrence of the current class of variable. <F1> will display a help screen whose contents correspond to the type of problem being input.

## Solution Navigation

DSS generates solutions to a disk file named LASTRUN.S and then displays the contents of this file on the screen. The arrow keys, <PGUP>, <PGDN>, <TAB>, and <BACKTAB> are the primary keys used for moving in a solution. <RIGHT> and <LEFT> scroll the output one column per key press, and <TAB> and <BACKTAB> scroll the output 80 columns per key press. <UP> and <DOWN> scroll the output one row per key press, and <PGUP> and <PGDN> scroll the output 22 lines per key press. <HOME> positions the output at the upper left boundary. <F1> will display a help screen whose contents



correspond to navigating output. <ESC> allows the user to quit or exit DSS, while <END> leaves the output and presents other options, such as printing the output or saving it.

The upper left corner of the solution screen displays a “Row,Col” indicator. This indicator shows the row and column values of the solution that corresponds to the upper left point of the screen. For example, when the solution screen is first displayed, the “Row,Col” indicator will show “1, 1.” After pressing <PGDN> once (assuming that the output spans multiple screen pages), the indicator will show “23, 1.” This indicator provides a reference point to the user to gauge what portion of the output is being displayed relative to the upper left corner.

## Graphics Navigation

All modules except Decision Analysis will generate a graphic representation of the solution, within the limits of the computer screen capability. Most of the graphics screens are simply displayed, with no navigational options open to the user, and the press of any key will return to the problem menu screen. However, the Forecasting/Regression module allows the user to press <SPACEBAR> to move the legend around the four corners of the screen, since the legend may obscure a portion of the graph. In this case, any key other than <SPACEBAR> returns to the problem menu. There is no <F1> help available for the graph screens, since no navigation is required.

### Special note for users with graphics-capable printers:

Each module in DSS provides some type of graphical representation of the solution. If you have a printer capable of printing graphics, you may be able to take advantage of a DOS utility for printing graphic images produced by DSS. The DOS command GRAPHICS, invoked before DSS is started, should enable your PC to print graphics screens when pressing <Shift+PrtScr> (pressing and holding down the “shift” key while pressing the “PrtScr” key). The syntax and capabilities of the GRAPHICS command have changed with each version of DOS, so you are urged to consult your DOS manual for the proper syntax for your DOS version. Later versions of DOS have support for specific printers from Hewlett-Packard and IBM, and the general form of the GRAPHICS command for those DOS versions is ‘GRAPHICS printername’. For example, if you have a Hewlett-Packard DeskJet printer, the proper syntax is ‘graphics deskjet’.

## Help Screen Navigation

Context-sensitive help screens are invoked by either selecting HELP from a menu or by pressing <F1>. The help text is displayed in a pop-up window in the center of the screen. Due to screen size limitations, only 13 help text lines are displayed. The help text can be scrolled forward by using the <PGDN> key or backward by using <PGUP>. Any other keystroke returns control to the place from which the help screen was invoked.

## Printer Control

DSS was designed to accommodate the most basic type of ASCII dot-matrix printer. All print is sent to the printer as a simple text-only ASCII character stream, directed to device