REVISED NUFFIELD ADVANCED SCIENCE

PHYSICS

DYNAMIC MODELLING SYSTEM

BBC MICROCOMPUTER HANDBOOK

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Preface

This computer assisted learning unit has been produced by Professor Jon Ogborn supported by the Computers in the Curriculum Project at Chelsea College. It was designed to be used in the Revised Nuffield A-Level Physics course as well as other secondary science courses.

The program has two parts: the operating system and a Physics models disk. The program is supported by a comprehensive guide on how to use the system with examples of how to create a model. A guide to the models disk is also provided, which describes each of the Physics models on the disk. The user is also able to create and save new models, thus building up a library of models to meet individual needs.

The system has been designed to meet the needs of different teaching methods, student abilities and class groupings. Additional guides and models disks are being developed for other subjects, for use in further and higher education as well as in the secondary school curriculum. This system has a wide range of applications in science teaching and can also be used in many other areas of the curriculum.

The Dynamic Modelling System is part of a wide range of computer assisted learning materials developed by the Computers in the Curriculum Project for use in education.

Margaret Cox
Project Director
1985

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Acknowledgements

This system has been developed in conjunction with the Computers in the Curriculum Project, part of the Educational Computing Section, Chelsea College. The principal author is Professor Jon Ogborn (Institute of Education).

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Margaret Cox
Project Director
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1 Introduction to dynamic modelling

The Dynamic Modelling System is a general purpose tool for use by teachers and students. It will plot graphs or tabulate values of any quantities the user instructs it to calculate. This is done either by writing into it a few instructions, usually only a few lines long, or by using a previously prepared program stored on disk.

The system can be used in a range of subjects and in a variety of ways.

Amongst the ways in which it can be used are:

- demonstration of a model;
- building up a model by discussion;
- exploring a new model, for example, for project work;
- teaching elementary programming.

A dynamic model of some real situation is a sequence of steps in which the way the system will evolve is calculated. Successive stages of its evolution are found by repeating the sequence, starting with the values found at the previous stage.

A very simple model of population growth will illustrate the idea of a dynamic model. For each population of rabbits, the new number of rabbits in each generation is the old number of rabbits plus the number of births. This can be expressed as below:

RABBITS = RABBITS + BIRTHS

or R = R + B

Suppose we start with two rabbits (R = 2) and add four births (B = 4) in each generation. This model would then generate the values R = 2, R = 6, R = 10, R = 14, and so on. All models in the Dynamic Modelling System work inside a repeating loop which calculates once through the instructions given, and then does this again and again, each time using the values from the last time around. Adding a second instruction to add one to the number of generations (say G) at each step can be done by inserting the line G = G + 1:

```
R = R + B
G = G + 1
```

A graph of R against G would be a straight line. Suppose we alter the model, and say that the number of births is proportional to the number of rabbits there happen to be:

```
B = F*R
R = R + B
G = G + 1
```

F might stand for fertility. Now the growth becomes exponential, the graph of rabbits against number of generations rising faster and faster. Next it would be possible to introduce a mortality rate, and perhaps to make that and the fertility rate depend on the density of the rabbit population or on other factors.

Models for the decay of charge on a capacitor or for the decay of radioactive materials are nearly as simple. Something similar to the rabbit model could represent an explosive reaction.

The point of the example is that:

- models can be built up from very simple starting points;
- being written as elementary steps for the computer, each step is usually easy to understand, and normally has a direct interpretation in terms of events in the situation being modelled;
- difficult mathematical functions (such as the exponential) need not be introduced before one can get results, and models which have no analytic solutions, or ones which are too advanced, can still be examined.

Examples of models

The Dynamic Modelling System can be used in a variety of subjects. A small selection of examples is given below. More extensive ideas can be found in the notes supplied with the models disk.

All the models are written using the syntax found in the programming language BASIC, for example the * symbol is used to represent multiplication.

Biology

The model below gives a logistic growth curve of population P against time T. G is a net growth rate, which diminishes

from the base rate GO as the population approaches a maximum M:

```
G = GO*(1 - P/M)
P = P + G*P
T = T + 1
```

Physics

Free fall under gravity can be modelled by:

```
F = -G*M
A = F/M
V = V + A*DT
S = S + V*DT
T = T + DT
```

The force F, determined by the gravitational field G and mass M, is used to calculate the acceleration A. The new velocity after time DT is found by using A, and the change of displacement after time DT is found by using V.

The model above is an example of how the system can be used to solve a differential equation. Another example would be that of capacitor discharge:

```
Q = C*V
I = V/R
Q = Q - I*DT
V = Q/C
T = T + DT
```

Q is the charge on a capacitance C at potential difference V, discharging with current I through resistance R.

Chemistry

A first order reaction would be very much like the last example:

```
DC = -K*C*DT
 C = C + DC
 T = T + DT
```

C is the concentration and K is a rate constant.

Economics, Geography

Resource depletion is one example amongst many. An introductory model might be:

```
G = K*(R - CL)/CL
C = P*R + G*C
R = R - C
T = T + 1
```

in which resources R are consumed at a rate C, which is a

proportion P of present resources plus growth G in consumption. G is decided by the present resources in relation to a critical level CL.

Mathematics and Computing

At an elementary level functions can be plotted. The behaviour of the sine function can be shown by:

```
S = SIN(W*T)
T = T + DT
```

2 Using the system

Outline of the system

You can see a short demonstration of the program and its commands, by pressing I (Information) when the introductory menu appears at the start of the program. Pressing M (Modelling) takes you into the modelling program itself.

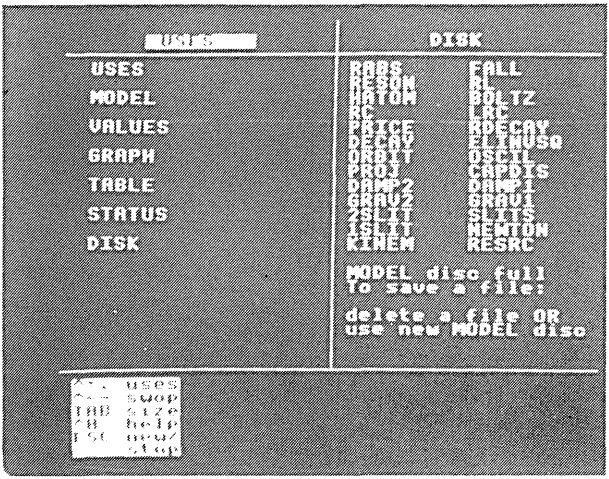


Figure 1 The screen at the start of the modelling program

Figure 1 shows the screen at the start of the modelling program. On the screen, the program gives you two working pads, side by side. One pad can be used to display information you need for the work you are doing on the other pad or you can compare results from two versions of the same model by using separate pads. Only one pad at a time can be used. On either pad you can do any one of seven kinds of task described overleaf.

Uses
The pad shows a list of the possible uses for the pads.

Model
This allows you to type in a model, read one from the models disk, alter a model you have or just look at it. The system provides a simple screen editor for typing in models, modifying them or correcting errors.

Values
This is used to type in, view or modify initial values for variables in a model. The editor used for models is also available here.

Graph
Graphs may be plotted of any two variables in the model. The positions of the axes and scales can be varied.

Table
This tabulates values of any pair of variables in the model.

Status
This checks whether the model, values or the choice of axes and scales, are yet to be specified.

Disk
This lets you see the names of models stored on the models disk, view their contents, and save a new model or delete an old one.

3 An exercise in using the system

In the exercise below you will see most of the system facilities at work. It starts on one pad. You type in a model on that pad using the editing facilities. Then, on the other pad, you give some initial values to the variables, again using the editor. On this pad, graph axes are set up and a graph is plotted. The model is still visible on the first pad.

Next, the values replace the model on the pad opposite the graph, a value is changed and a new graph is plotted.

Then the model itself is altered by bringing that back on a pad and editing it. The effect of the change is shown by having the new graph drawn side-by-side with the old one, using both pads.

Finally you see how to store a model on the models disk, and how to recall one from the disk.

Start up the system with the Dynamic Modelling System disk in the disk drive (drive 0 of a double disk drive). Hold down the SHIFT key and press and release the BREAK key.

The introductory menu appears on the screen:

M	Modelling
I	Information
D	Drives (1 or 2 shown)
C	Colour (current colours shown)
Q	Quit

Writing a model

- Press **M**

You will be asked to insert a models disk, and press RETURN.

The two pads appear on the screen. The righthand one shows the models stored on disk, whilst the lefthand one shows the uses to which you can put either of them. This is shown in Figure 1. The lefthand pad is the one you are

currently working on, as shown by its label (USES) being highlighted.

Hold down the CTRL key and press the 'down' arrow key. This labels the lefthand pad MODEL and brings up a menu of commands for writing models.

Pressing the CTRL keys and the 'up' and 'down' arrow keys cycles through the possible pad uses. Each use is shown at the head of a pad. Release the key and wait. The pad will pick up the use currently shown above it. It may be useful to practice running through the possible uses using the CTRL key and the 'up' or 'down' arrow keys. Pressing the CTRL keys with the 'left' and 'right' arrow keys enables you to swop pads. Finish with the lefthand pad heading as MODEL.

When the lefthand pad is headed MODEL. You can either:

- type model equations onto the pad;
- use the editing keys, for example, to move the cursor.

The editing keys are the function keys f0 to f5, DELETE and the arrow keys. The arrow keys move the cursor, CTRL **not** being pressed. The arrow keys used while pressing CTRL alter the pad use (as above), or swop between pads. TAB changes the pad size. CTRL H calls up a message explaining the use of the editing keys.

First we will type in a model.

- Type **R = R + B (RETURN)**

This model equation is printed on the pad and is now part of the model.

According to the equation, the new value of R is to be assigned the old value plus B. All assignments in BASIC may have only one variable on the left of the = sign.

If you make typing errors, use the DELETE key or press key f0 to rub out a letter, or key f1 to rub out the whole line at the cursor. Key f2 makes space for a new line between two others. Such commands take effect at the current cursor position.

- Type **G = G + 1 (RETURN)**

This line is added to the model.

- Type **B = F*R (RETURN)**

This line is added. Now there is a problem: this line should be the first, not the last, since B is needed to calculate R. However, the editor allows lines to be moved up or down.

- Use **'up' or 'down' arrow keys**

Position the cursor on the line which reads B = F*R.

- Press the **f3 key**

This moves the last equation up one line. Repeat until it becomes the first equation.

You should now have the following equations on the pad, as shown in Figure 2:

B = F*R
R = R + B
G = G + 1

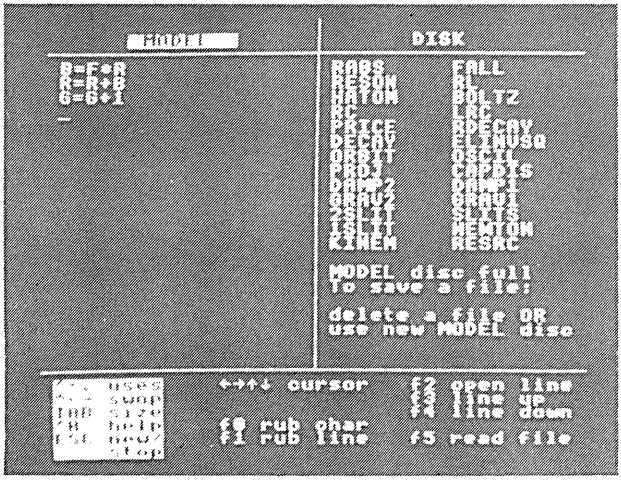


Figure 2 Entering a model

Setting values

- Press the **CTRL key** and the **'right' arrow key**

This will move you to the righthand pad, currently used to show models on the disk.

- Press the **CTRL key** and **'down' arrow key**

When the label VALUES appears release and pause, to use the new pad for initial values.

- Type **R = 2 (RETURN)**
- Type **G = 0 (RETURN)**
- Type **F = 0.1 (RETURN)**

These will make the model calculation start off with R = 2 rabbits and a fertility F of 0.1 at generation zero.

The same keys can be used to edit values as were used in the MODEL option.

Plotting a graph

- Press the **CTRL key** and **'down' arrow key**

Choose STATUS as the use for the pad. You do not need to change pads.

This gives the model a status check to see if anything has not been set. You have written a model and its values, but not yet chosen the graph axes or scales. So you should get the message:

Waiting for:

x-variable
y-variable
x-maximum
y-maximum

- Press the **CTRL key** and **'up' arrow key**

Choose the righthand pad use as GRAPH. Graph axes are drawn on the pad, with '?' printed for variables and maximum values. A new menu of graph commands appears in the bottom of the screen.

- Press the **f1 key**

This asks for the variable to go on the *Y*-axis.

- Type **R (RETURN)**

This will place R on the *Y*-axis.

- Press the **f0 key**

This asks for the variable to go on the *X*-axis.

- Type **G (RETURN)**

This will place G on the *X*-axis.

- Press the **f3 key**

This asks for the largest value of R.

- Type **200 (RETURN)**

The maximum value of R is set at 200.

- Press the **f2 key**

This asks for the largest value of G.

- Type **50 (RETURN)**

The maximum value of G is set at 50.

Press the arrow keys to move the axes. They can be put back in place again using the arrow keys. The zero on the graph is assumed to be at the origin of the axes, so that the scales are decided by giving the maximum values. The origin may be put anywhere on the pad.

The Dynamic Modelling System is now ready to do calculations and plot the results. The preliminaries take less time as you get used to the system, and since models complete with all other data can be stored, such a stored model can run almost immediately after starting.

- Press the **f5 key**

The system checks the equations and values, and then starts to plot. With the values above you should get a good exponential curve.

- Press the **f4 key**

This cleans the graph pad.

- Press the **f5 key**

This runs the model again.

- Press the **SPACE bar**

This stops the graph while it is being plotted.

- Press the **f6 key**

Editing

- Press the **CTRL key** and **'left' arrow key**

This moves the lefthand pad.

- Press the **CTRL key** and the **'down' arrow key**

Select the VALUES option. Figure 3 shows the graph on one pad and values on the other.

- Use the **arrow keys**

Put the cursor on the '1' in the line F = 0.1. Use f0 to rub out the '1' and then type '2', making F = 0.2. Rub out any mistakes with the f0 or DELETE keys.

- Press the **CTRL key** and **'left' or 'right' arrow key**

This returns you to the righthand pad, and takes up its previous use as a graph plotter.

- Press the **f5 key**

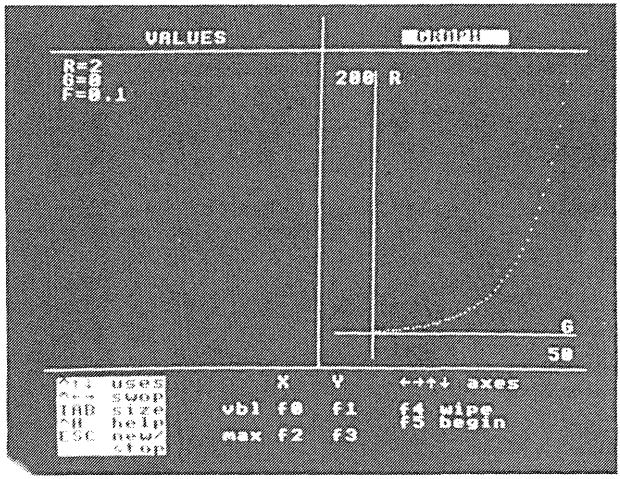


Figure 3 Looking at values and a graph

You should get a more rapid exponential growth than previously.

Having altered a variable, we will next alter the model itself, making the fertility dependent on how crowded the rabbits are and therefore not constant.

- Press the **CTRL** and the **'right' arrow key**

This takes you to the other pad.

- Press the **CTRL key** and the **'up' arrow key**

Choose the MODEL use for the pad.

The model equations appear. Put the cursor on the top line, and press the up arrow again to take it above the top line. This makes a space for a new line above the first. Type in the new first equation:

$F = F0*(1 - R/M)$

This makes the F decrease as the number of rabbits gets closer to a maximum value M.

We now have to specify initial values of the basic fertility F0 and the maximum M.

- Press the **CTRL key** and the **'down' arrow key**

Choose the VALUES heading for the pad.

- Use the **arrow key** and **DELETE key**

Change F = 0.2 to F0 = 0.2. Put the cursor at the end of the

variables and type M = 100. Now the two new variables introduced have initial values.

- Press the **CTRL key** and the **'down' arrow key**

Choose GRAPH for the current (lefthand) pad, leaving the original graph on the righthand pad.

- Press the **f5 key**

You should now obtain a growth curve which rises at first and then reaches a maximum. With the two graph pads side by side the graphs can be compared, as shown in Figure 4.

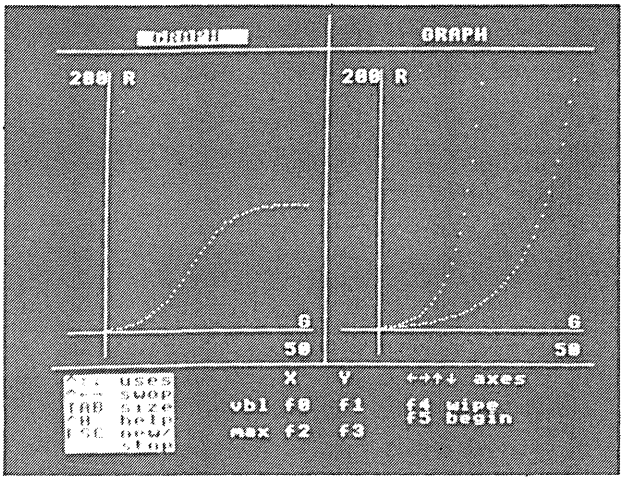


Figure 4 Comparing graphs

Different types of output

- Press the **TAB key**

This gives, on the big graph pad, a graph suitable for demonstration.

- Press the **f5 key**

The program will start plotting the graph.

- Press the **TAB key**

This returns the program to the two pad system.

- Press the **CTRL key** and the **'up' or 'down' arrow key**

Choose TABLE as the heading, which sets up a table of values to be printed on the pad. The variables tabulated are those

chosen for the graph, but can be altered as for the graph by using f0 and f1 keys.

- Press the **f5 key**

This begins to tabulate the values.

- Press the **SPACE bar**

This halts the production of tabulated values.

- Press the **f6 key**

This continues to give tabulated values.

It is often very useful to see a table before plotting a graph, so as to get an idea of appropriate scale values. A table will often show why a graph appears not to plot, for example if the values are off the scales or are all zero.

- Press the **CTRL key** and the **'up' or 'down' arrow key**

Choose DISK as the pad heading. This shows the names of any models at present stored on the MODEL disk.

- Press the **COPY key**

This asks for the model you have just written to be saved (stored) on the models disk. The program asks for a name for the model: use a name which is **not** already in use. Its name will be added to the list of stored models shown on the screen.

- Press the **ESC key**

ESCape lets you exit from the program, or start again with a new model. You are asked if you want finally to quit (Q), to continue (C) with the present model (in case of mistakes), or to start again (N) with a new model, with an empty system as at the start.

If an error occurs in running a model, the system takes you to the same choices as if you pressed ESCape. Key C (continue) lets you get back to where you were and correct the error.

- Type **N**

This will take you back to where you were, with a pad in use for DISK operations. This brings up the list of models, including your new one, which are stored on the models disk.

- Press the **CTRL key** and the **'up' or 'down' arrow key**

Choose the MODEL heading on the pad.

- Press the **f5 key**

Give the name of your model. It will be read off the disk and the model equations shown.

- Press the **CTRL key** and the **'down' arrow key**

Choose GRAPH and see the graph axes now with labels of what to plot and scales, all stored on the disk from last time.

- Press the **f5 key**

This begins to plot the graph.

- Press **ESC**
- Press **Q**

This enables you to exit from the program.

4 System description

Machine requirements

You require a computer with a single or double disk drive. Colour and monochrome monitors or television sets can all be used.

Minimum specification:
A BBC microcomputer Model B, with an Operating System 1.2 or later.

Starting and setting up the system

You need two disks: the Dynamic Modelling System disk, and a models disk which you will use to call up or to store models. If you are not using the models disk supplied, you need a ready formatted disk for this purpose.

On a double disk drive system, the Dynamic Modelling System disk goes in drive 0, and the model disk in drive 1.

If you have a single disk drive, begin with the Dynamic Modelling System disk in the drive. After the program starts you will be prompted to insert the models disk. The Help commands require the Dynamic Modelling System disk to be reinserted in the drive.

To start up the system, with the Dynamic Modelling System disk in drive 0, hold down the SHIFT key and press and release the BREAK key. Alternatively, type CHAIN 'WELCOME' and press RETURN. This loads and runs a program which sets up parameters and settings for the main modelling program. It is essential to enter the system in one of these ways, as otherwise the system parameters and settings will not be correct.

The initialising program reads from the disk settings for the computer and display in use. It shows the current settings, for example:

D Disks 2
C Colour:
yellow on blue

Pressing D changes the number of disk drives from 2 to 1 or back. All the allowed colour settings are shown when C is pressed repeatedly. With a monochrome display, the colour is best set to either white on black or black on white. These settings remain for subsequent use of the system until altered again.

System facilities and restrictions

Use of BASIC in models

Models are written as lines of BASIC. They will be computed in sequence, looping to the beginning after plotting or tabulating values from the current iteration. Thus, the sequence of instructions is usually important.

Line numbers are not used; the program inserts them when it uses the model. Each line on the screen is treated as a new instruction. Thus lines **cannot** carry over from one line to the next.

The system does **not** check if the model is 'correct'. If anything is wrong and the computation fails, you will get an error message and the chance to re-start the system.

To define variables you can use words of any length, mixing lower and upper case characters. The system's own variables all end with % (this symbol has been disabled so that you cannot use it).

You cannot use array variables.

In writing models and variable values you can use the arithmetic operators:

+ (addition)	− (subtraction)
* (multiplication	/ (division)
= (equals)	↑ (exponent)

You need not use LET statements, though you may do so. You can use the colon (:) for multiple statements on one line.

The system also allows use of all the arithmetic functions provided in BBC BASIC:

ABS-absolute positive value
ACS-arc-cosine
ASN-arcsine
ATN-arctan

COS-cosine
DEG-radians to degrees
DIV-integer division
EXP-exponential
INT-integer part of number
LN-natural logarithm
LOG-logarithm base 10
MOD-remainder after integer division
PI-(3.14159265)
RAD-Degrees to radians
RND-random number
SGN-sign
SIN-square root
TAN-tangent

These functions are best used with brackets, for example LOG(R). Brackets may also be used in arithmetic expressions, for example X = Y*(P + Q).

Logical control functions can be used:

= > <
AND OR NOT
IF THEN ELSE
REPEAT UNTIL
FOR TO STEP NEXT

REM statements are allowed.

Functions, or arithmetic expressions, may also be used either in giving initial values, or in labelling axes or tables. Thus, one can plot LOG(R) instead of R, or set an initial variable equal to the sine of an angle or to a random number.

Important warning: If you use other BASIC keywords, for example PRINT, CLS and so on, the system will act on them just as it would as part of any BASIC program. It is therefore essential to avoid them. In particular, they must not form the first letters of a variable name. The safest way is to use lower case letters for variables.

Certain keyboard symbols which have special effects in BASIC have been altered or disabled.

Size of a model

When working with a two pad display, the number of lines in a model, and the number of characters on any one line, is restricted to what will fit on a pad. Lines which are too long to fit would need to be rewritten as two lines. For example, the energy E on the next page:

E = 0.5*M*(VX↑2 + VY↑2) + M*G*SY

written as two terms, could be split into its two parts, adding them afterwards:

KE = 0.5*M*(VX↑2 + VY↑2)
PE = M*G*SY
E = KE + PE

By moving to the large one pad display, lines can occupy most of the screen width. Such a model cannot be displayed on two pads, and, if the system contains a model with lines longer than the width of a small pad, it switches automatically to large pad working if the MODEL use of a pad is called for. The disadvantage is that one cannot then show a model and, say, values or a graph at the same time.

Screen editor

A screen editor is used for writing or modifying models or initial values of variables. It provides for:

- typing characters to the screen;
- deleting characters at the cursor or to the left of the cursor;
- erasing a whole line;
- inserting an empty line;
- moving a whole line up or down.

Models can be read in from disk, when in the editor. A list of those available can be obtained by using the other pad for DISK, where one can also look at the content of a model without actually reading it into the present model. A model read in is inserted into any model that currently exists, starting at the current cursor line position. In this way parts of models can be assembled in the correct places even if not read in the correct sequence. If necessary all or part of it can be moved afterwards, using the line up or line down facilities, to get the correct sequence.

Disk storage of models

Models are stored on (saved to) and read from a models disk. This may be one supplied with the system, or a blank disk (formatted for the machine in use) supplied by the user. In this way, different teachers or students can have their own models disks while using the same modelling system.

The models are stored with the names you give them, prefixed by M, for example M. CHANGE where the model is called 'CHANGE'. Names given must **not** include punctuation marks and may not be more than seven characters long.

Graphs and tables

The origin is defined as the point where the axes of the graph cross. They can be moved to place the origin where it is needed. Scales are chosen by giving the maximum positive value of each variable. It follows that the scaling changes if the axes are moved and the maxima are left the same.

To plot graphs with a 'false origin', give the variable to be plotted as the actual value minus the value at the origin. For example, to plot YEAR from 1900 onwards, specify 'Year-1900' as the variable to be plotted.

The tabulating facility gives numerical values of a pair of variables. The two variables are in common with the graph facility so that which is plotted is what is tabulated, and vice-versa. It is, of course, possible to alter what is tabulated or plotted. Values tabulated are shown with three significant figures. (Integers from 1000 to 9999 show all four digits).

Help messages

Help messages are available to give a fuller explanation of each menu of commands, obtainable by pressing CTRL H. The help message obtained when the pad in use is showing USES gives an explanation of the pad control commands which are available in every menu: pad swopping, pad size and changing pad use.

Crashing

The Dynamic Modelling System is a program that, when instructed by the user, programs itself. Thus, it can crash, as can any program you write directly, for example, if you divide by zero. If this happens, the error is 'trapped' and the program proceeds to a point which allows you to start again or correct your fault.

Replies to unwanted prompts

If a command key such as that needed to save a model or to label an axis is accidentally pressed, the system will be waiting for a reply, the name of the model or the variable to plot, for example. In this case just press RETURN, and the command will be cancelled.

5 Guide to system commands

A chart showing the menus of commands in the system, and how each is reached from others, can be found on the back cover of this booklet.

Introductory menu

M Starts up the modelling program.

I Gives an introductory demonstration of the System facilities.

D Pressing D alters the number of disk drives to be used. Make sure that 'drives 1' is displayed if you have only a single drive.

C Pressing C alters the colour settings. Set for black on white or white on black for a monochrome display.

Q Quits from the modelling system.

Pad use commands

CTRL key and the 'up' or 'down' arrow key	scroll the pad uses on the pad currently in use. To select a use, scroll until the use heading shows, then release the keys and wait for a moment.
CTRL key and 'left' or 'right' arrow key	switch to the pad currently not in use, picking up its previous use.
TAB key	switch from using two small pads to one large one, and back again.
CTRL key and H key	call up a help message for the current use.
ESCape key	go to the finishing menu, where you can start again with a new model or exit from the system.

Editing commands

MODEL and VALUES	both use the editor.
The arrow keys	move the typing cursor and type in models or variables.
DELETE key	rub out the character to the left of the cursor.
f0 key	rub out the character at the cursor.
f1 key	rub out the whole line at the cursor.
f2 key	insert an empty line at the cursor.
f3 key	move the line at the cursor one line up.
f4 key	move the line at the cursor one line down.
f5 key	read a file from disk, asking for its name. The file is put into any model already present, starting at the current cursor line.

Graph commands

The arrow keys	move the graph axes.
f0 key	choose or alter the *X*-variable plotted.
f1 key	choose or alter the *Y*-variable plotted.
f2 key	choose or alter the maximum of the *X*-variable.
f3 key	choose or alter the maximum of the *Y*-variable.
f4 key	wipe the pad and redraw the graph axes.
f5 key	begin plotting: stop at the edge of the pad.
f6 key	continue plotting (after a halt).

Table commands

f0 key	choose or alter the first variable tabulated.
f1 key	choose or alter the second variable tabulated.
f4 key	wipe the table of values.

f5 key	begin tabulating: stops when the SPACE BAR is pressed.
f6 key	continue tabulating (stops again when the SPACE BAR is pressed).

Disk commands

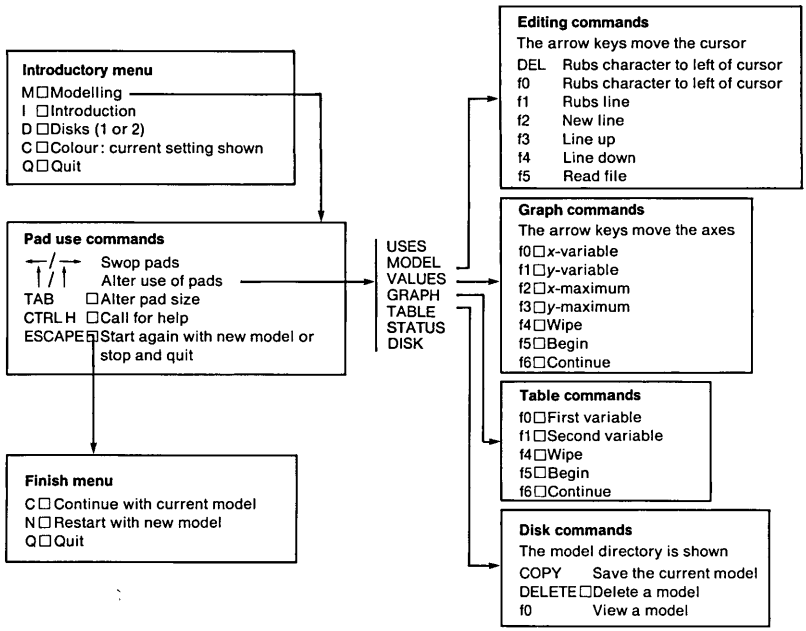
The names of models filed on the models disk are displayed.

COPY key	save the current model on the disk. A model name is requested.
DELETE key	delete a named model from the disk.
f0	view a model on the disk. The model is **not** made part of the current model.

Finish commands

These are obtained by pressing the ESCape key at any time. They are also reached if an error occurs, when an error message is also printed.

C key	restart and continue with the current model. This is useful when an error has occurred.
N key	start again with no model in the system.
Q key	exit from the Dynamic Modelling System.


Introductory menu
M☐Modelling
I ☐Introduction
D ☐Disks (1 or 2)
C ☐Colour: current setting shown
Q☐Quit
Pad use commands
Swop pads
Alter use of pads
TAB ☐Alter pad size
CTRL H ☐Call for help
ESCAPE☐Start again with new model or stop and quit
Finish menu
C☐Continue with current model
N☐Restart with new model
Q☐Quit
USES
MODEL
VALUES
GRAPH
TABLE
STATUS
DISK
Editing commands
The arrow keys move the cursor
DEL Rubs character to left of cursor
f0 Rubs character to left of cursor
f1 Rubs line
f2 New line
f3 Line up
f4 Line down
f5 Read file
Graph commands
The arrow keys move the axes
f0☐x-variable
f1☐y-variable
f2☐x-maximum
f3☐y-maximum
f4☐Wipe
f5☐Begin
f6☐Continue
Table commands
f0☐First variable
f1☐Second variable
f4☐Wipe
f5☐Begin
f6☐Continue
Disk commands
The model directory is shown
COPY Save the current model
DELETE☐Delete a model
f0 View a model