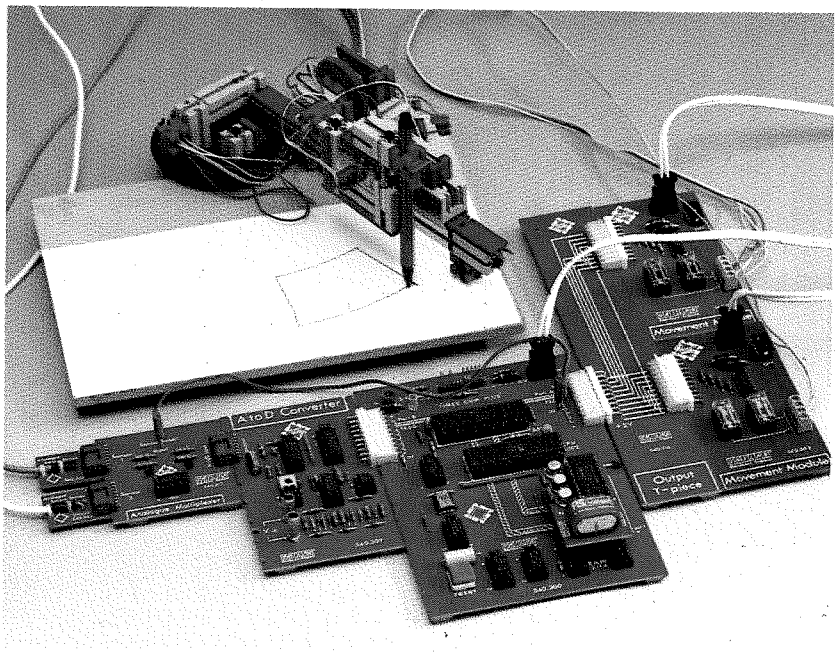
CONTROL PATHWAYS

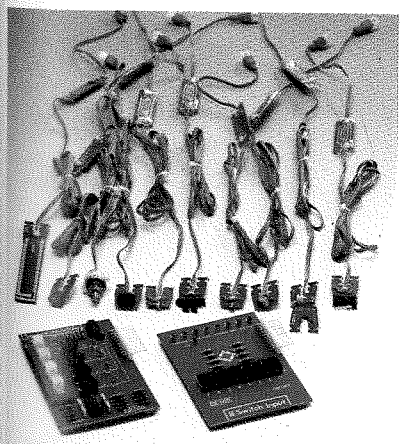


Following on from Control For All, CONTROL PATHWAYS provides a flexible set of resources including sensors, input circuits, output circuits and devices, and a variety of central controllers, together with pupil texts and manuals. It covers all aspects of control from simple input of digital information such as touch, light level, temperature level, etc., through to analogue-to-digital conversion, displays, stepper motor control and d.c. motor speed control. 'Control Pathways' adopts the same systems approach as 'Microelectronics For All'. Indeed many of the parts of 'MFA' can be used in 'Control Pathways', such as the LEGO® Buggy, the Movement and Music Modules, the Computer Module, etc., as the two kits have been designed with the maximum amount of compatibility possible. Similarly, the 'Control Pathways' Sensors can be used with ALPHA (page 90), the MFA Decisions Module Mk II (page 99), MTR Logic and Op-Amp Boards (pages 105 and 106), as well as the Extension Module in 'Control For All' (page 108).

One other area of flexibility is in the choice of 'central controller' which acts as the decision maker between the input devices and the outputs. The pupil and teacher materials have been designed so that the 'brain power' can either come from a computer via an MFA Computer Module, or from a microprocessor-controller: 3 Chip Plus. The following sections explain each of these elements in 'Control Pathways'.

NOTE: All items in this section on 'Control Pathways' and '3 Chip Plus' carry MEP-approved nett prices, and are not subject to further discount.

INPUTS AND SENSORS



There are three INPUT boards in the 'Control Pathways' range. Each plugs into the left-hand edge connector of the central controller which you are using.

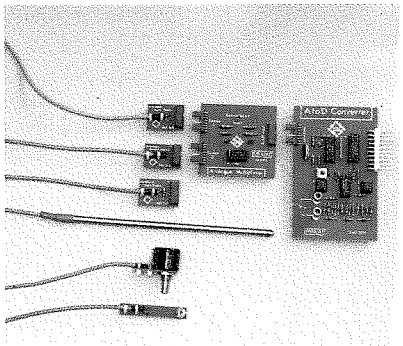
8 Switch Input—contains eight 2-position slide switches so that any 8-bit pattern of '1s' and '0s' can be set quickly; also provides eight 2 mm sockets so that external switches can be attached to any of the eight input lines (note that the slide switch must be moved to the '1' position to enable the 2 mm socket to control that line).

Sensor Module—provides digital '1s' and '0s' on the lowest four data lines only; these logic signals are provided by Sensors (see below) which plug into the special polarised sockets; since many of these sensors do not give a full logic change (e.g. the thermistor, the LDR, etc.), each input is passed to a comparator whose sensitivity can be adjusted by an on-board potentiometer; when the signal level crosses the threshold set by this potentiometer, the comparator passes a full logic change to the controller.

Digital Sensors—there are ten different digital sensors, each of which can be plugged into any socket on the Sensor Module; the Sensors are designed so that any balancing resistors are carried on a 'patch' board built into the Sensor's cable; the sensing components are mounted on a specially designed clip which will attach to TESTBED POLYMEK, LEGO® bricks, Fischertechnik, Meccano or similar system; the sensors are:

Temperature Sensor (thermistor)
Microswitch
Reflective Optoswitch
Slotted Optoswitch
Liquid Sensor
Light Sensor (phototransistor)
Tilt Switch
Potentiometer Sensor
LDR Sensor (ORP12)
Reed Switch Sensor (with magnet)

540.303 8-SWITCH INPUT	£12·20
540.312 SENSOR MODULE	£13·90
540.350 TEMPERATURE SENSOR	£5·85
540.351 MICROSWITCH	£7·07
540.352 REFLECTIVE OPTOSWITCH	£9·47
540.353 SLOTTED OPTOSWITCH	£7·29
540.354 LIQUID SENSOR	£6·50
540.355 LIGHT SENSOR	£6·25
540.356 TILT SWITCH	£8·90
540.357 POTENTIOMETER SENSOR	£8·88
540.358 LDR SENSOR	£6·94
540.359 REED SWITCH SENSOR	£8·60



A-to-D Converter—produces an 8-bit number which represents the size of an input voltage within the range 0 to 5 V; the input voltage can be supplied to the board via two 4 mm sockets, via an Alphalink from one of the range of Alpha transducers, or from one of three Analogue Probes (see below) which connect to the Converter via a special plug and socket.

Analogue Multiplexer—connects to the A-to-D Converter to allow two Analogue Probes to give voltages; the required channel is selected by connecting a 2 mm Lead from the 'select' terminal on the Multiplexer to an output terminal of the central controller.

Analogue Probes—there are three probes to connect to the A-to-D Converter.

Analogue Temperature Probe.

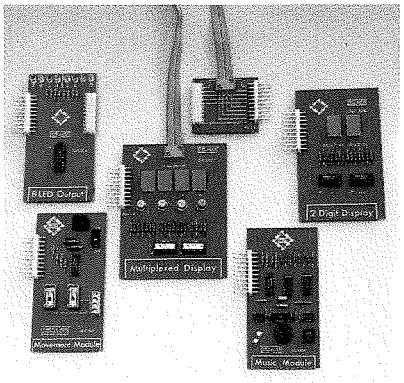
Analogue Light Probe (ORP12).

Analogue Rotary Sensor (a multi-turn potentiometer which can be used to provide positional information to the controller when attached to a wheel or axle).

540.309
A-to-D CONVERTER. . . . . £18·70
540.313
ANALOGUE MULTIPLEXER . . . . £5·16
540.340
ANALOGUE TEMPERATURE PROBE . . . . . £8·98
540.341
ANALOGUE LIGHT PROBE . . . . . £8·19
540.342
ANALOGUE ROTARY SENSOR. . . . . £10·45

OUTPUTS

There is a large variety of OUTPUT devices which plug into the right-hand edge connector of the central controller which you are using.



8-LED Output—each of the eight output lines can drive one of the LEDs on this board; there are three red, three green and two yellow LEDs; the eight output lines are repeated through to an edge connector on the right-hand side, so that any other output module may be plugged in.

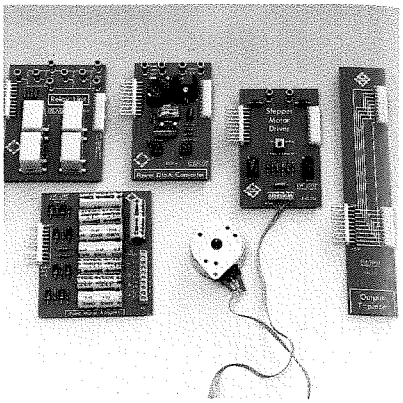
4-Digit Multiplexed Display—this board is unique in that it can only be used with the '3 Chip Plus' controller because it requires 12 lines to be set for output; a secondary board plugs into the left-hand edge connector of the controller which leaves lines 0 to 3 free for input but sets lines 4 to 7 as outputs; the controller uses these lines to select which of the four displays is to be addressed, the normal output providing the character which is to be written to that display; each segment of each display can be separately addressed, so that letters and words can be displayed as well as numbers (the 'MFA' Computer Module cannot use any of the left-hand edge connector for output and so cannot be used with this Module).

2-Digit Display—contains two seven-segment displays each of which can display a number between 0 and 9; output lines 0 to 3 control the right-hand display, and bits 4 to 7 control the left-hand display.

'MFA' Music Module—accepts numbers between 0 and 15 (lines 0 to 3) and produces notes from a small speaker.

'MFA' Movement Module—also accepts numbers on lines 0 to 3 but decodes these as instructions to switch two on-board relays; this can switch on and off two small d.c. motors such as on the LEGO® Buggy.

540.304
8-LED OUTPUT . . . . £7·80
540.307
4-DIGIT MULTIPLEX DISPLAY . . . . . £23·40
540.308
2-DIGIT DISPLAY. . £11·56
540.004
'MFA' MUSIC MODULE . . . . . £10·80
540.005
'MFA' MOVEMENT MODULE . . . . . £10·40



D-to-A Converter—uses output bits 0 to 3 to select the size of voltage available from the 4 mm output sockets; the voltage from a 12 V power supply can be controlled in seven equal steps from 0 to 12 V, and may also be reversed in polarity; the board can deliver significant current (up to 0·5 A) and so can be used to control heaters, d.c., motors, etc.

4 Relay Unit—contains four heavy-duty SPDT relays able to switch up to 5 A at 25 V (note: total board current is 5 A); has a special edge connector to which only the Point Motor Adaptor can be connected.

Points Controller—plugs into the Relay Unit only and is designed to control four PECO N-gauge railway point motors.

Stepper Motor and Driver—a 7·5 degree per step motor controlled by two bits (forward/reverse and step) which can either be bits 0 and 1 or bits 2 and 3 selected by an on-board switch; the eight output lines are repeated to the right-hand edge, so two boards could be controlled either in parallel (both using bits 0 and 1) or independently; with the Output T-Piece, four stepper motors could be controlled independently.

Output T-Piece—allows those output boards controlled by only four lines, to be controlled by the other four lines; thus a Movement Module could be controlled at the same time as a D-to-A Converter.

540.306
POWER D-to-A CONVERTER. . . . . £20·29
540.310
4-RELAY UNIT. . . . £22·59
540.311
MODEL RAILWAY POINTS CONTROLLER. . . . £13·80
540.314
STEPPER MOTOR AND DRIVER . . . . . £24·90
540.316
OUTPUT T-PIECE . . £5·56

PACKS OF PERIPHERALS

The input and output boards in Control Pathways may be purchased individually as above. Alternatively, there are two packs available as follows:

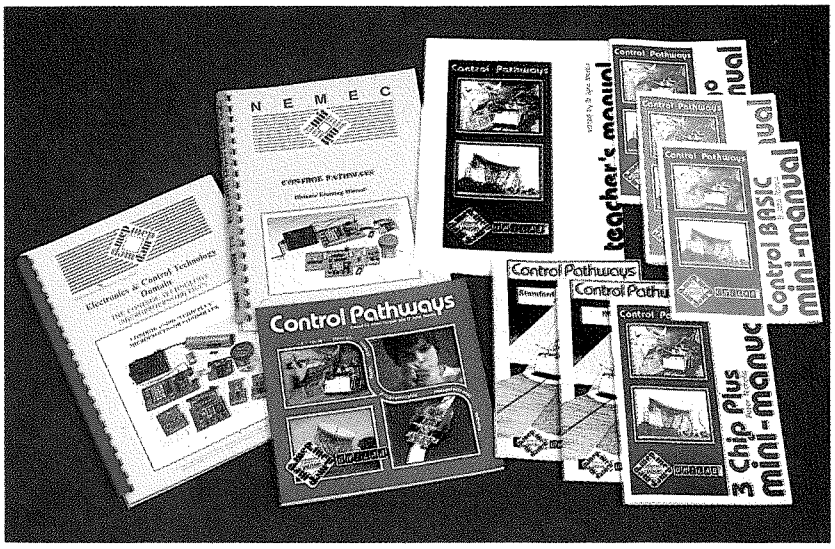
The **Control Pathways Peripherals Pack** contains one of each of most Input, Output and Sensor units: 1 Teacher's manual, 1 MFA Music Module, 1 MFA Movement Module, 1 8-Switch Input, 1 8-LED Output, 1 Power D-to-A Converter, 1 2-Digit Display, 1 4-Relay Unit, 1 A-to-D Converter, 1 Analogue Temperature Probe, 1 Analogue Light Probe, 1 Analogue Rotary Sensor, 1 Sensor Module, 1 Temperature Sensor, 1 Microswitch, 2 Reflective Optoswitches, 1 Light Sensor, 1 LEGO® Universal Buggy, 1 MFA Battery Holder, 1 PJ996 battery.

The **Control Pathways Supplementary Pack** contains additional quantities of the most useful units. Together with a Peripherals Pack, it should provide sufficient quantities to act as a class resource for project work in Control: 4 8-Switch Input, 4 8-LED Output, 1 Power D-to-A Converter, 1 2-Digit Display, 1 4-Relay Unit, 1 Railway Points Controller, 1 Stepper Motor and Driver, 2 Output T-Piece, 1 A-to-D Converter, 1 Analogue Multiplexer, 2 Sensor Module, 1 Temperature Sensor, 1 Microswitch, 1 Slotted Optoswitch, 1 Liquid Sensor, 1 Light Sensor.

540.275
CONTROL PATHWAYS PERIPHERALS PACK . . . . . £233·61
540.276
CONTROL PATHWAYS SUPPLEMENTARY PACK . . . . . £268·88

CONTROL PATHWAYS PUBLICATIONS

The course materials for 'Control Pathways' have been designed in an interesting way; one which tries to meet the difficulties associated with the large variety of different computers and languages which are in use today. In addition, the central controller may be a microprocessor-based system, such as '3 Chip Plus' (see page 114). The Control Pathways publications also take this possibility into account. The work is directed from a central Pupil's Text. Where specific information or instructions on software are required, a supplementary 'Mini-Manual' provides the details relevant to the computer and/or language being used, or the '3 Chip Plus' microprocessor controller.



Pupil's Text—aims to stimulate interest through its attractive layout and abundance of examples and references to everyday control situations; directs pupils through a series of core and extension investigations in the following areas: OUTPUTS, SEQUENCES, DIGITAL AND ANALOGUE INFORMATION, INPUTS, FEEDBACK, ANALOGUE-TO-DIGITAL CONVERSION, PROJECT POSSIBILITIES: problems are analysed at a very general level and programs presented in the form of Structured Flow Diagrams so that good software technique is encouraged: 1 per pupil group required.

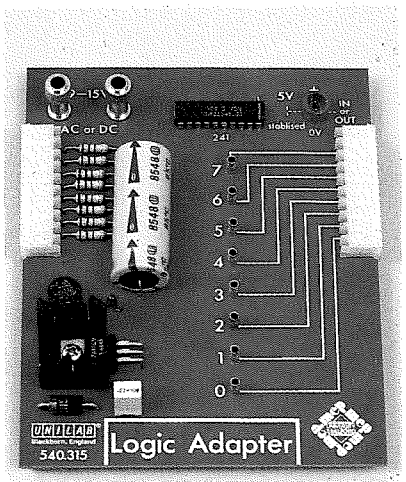
Mini-Manuals—a set of six books containing detailed instructions and programs for the investigations described in the main Pupil's Text: four of the books relate to different languages used on BBC Microcomputers, the fifth mini-manual would be used by those with RM or Sinclair computers: the last mini-manual relates to the '3 Chip Plus' Microprocessor: after each exercise, the pupil is referred back to the main text: 1 mini-manual per pupil group required.

Control Pathways Teacher's Guide—a manual containing comprehensive background information, details on the functioning of each of the peripherals and sensors, advice on classroom management, worksheet suggestions, project possibilities, assessment, etc.

The area of Control is very daunting to those faced with introducing the subject for the first time. The 'Control Pathways' materials were produced as an MEP project, and to help teachers become familiar with the work, a 'Green File' has been produced which can be used for self-directed learning. This is the **Control Pathways Distance Learning File**. You would also require one copy of the Pupil's Text and the Mini-Manual for your chosen combination of computer and language, together with the appropriate Computer Module and a range of sensors and peripherals. The Control Pathways Peripherals Pack (510.275—see page 111) contains exactly those peripherals and sensors required for the Distance Learning course. A second MEP Green File is available specifically for those using a microprocessor system: the **Control Pathways ('3 Chip Plus' Microprocessor) File**.

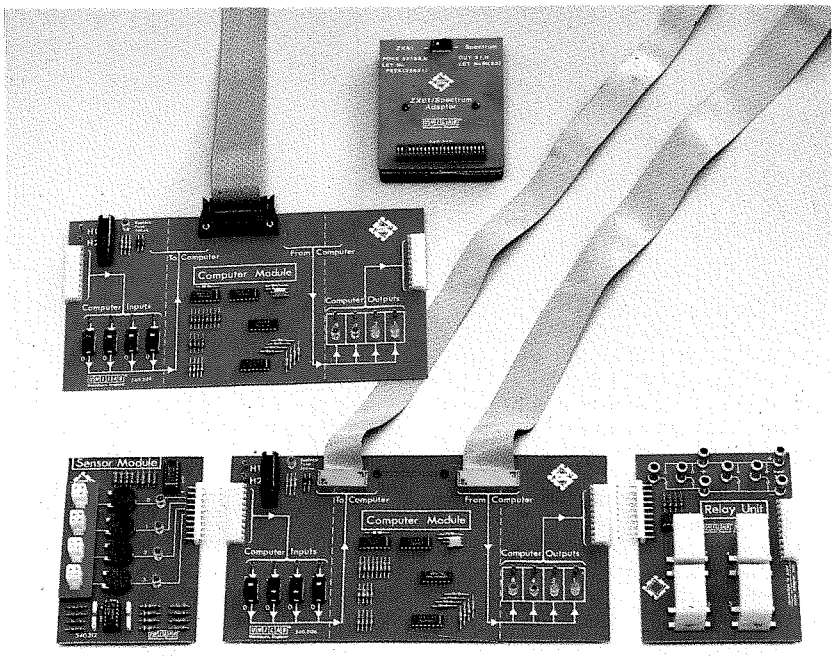
990.093
'CONTROL PATHWAYS' PUPIL'S TEXT . . . . . £6·00
990.094
'3 CHIP PLUS' MINI-MANUAL . . . . £4·25
990.095
MCL MINI-MANUAL (for BBC) . . . . . £2·00
990.096
CONTROL BASIC MINI-MANUAL (for BBC) . . £1·50
990.097
BBC BASIC MINI-MANUAL (for BBC) . . £1·50
990.098
CONTROL LOGO MINI-MANUAL . . . . . £2·00
990.099
STANDARD BASIC MINI-MANUAL (for RM and Sinclair) . £2·00
990.100
'CONTROL PATHWAYS' TEACHER'S GUIDE . £4·60
990.108
MEP 3 CHIP PLUS MICROPROCESSOR FILE . . . . . £6·00
990.109
MEP CONTROL PATHWAYS DISTANCE LEARNING FILE. . . . £3·00

CONTROL PATHWAYS LOGIC ADAPTER



Many schools already have digital microelectronic trainers and equipment, often based on 2 mm sockets, and may wish to use them with 'Control Pathways' input peripherals and sensors. The 'Control Pathways' Logic Adapter achieves this. It can be powered by 9 to 12 V a.c. or d.c. from a low voltage power supply to provide 5 V regulated for the peripherals. The 5 V regulated p.d. can also be taken from a socket to power external circuitry. Input peripherals such as the Sensor Board may then be connected to the left-hand edge connector in the normal way. The state of each line is repeated both to the eight lines of the right-hand edge connector, and to eight 2 mm sockets on the front panel. These points may then be taken to appropriate input sockets on the external circuitry for processing, etc. The external logic could be provided for example by Blue Chip boards, or by the Digital Microelectronics Board (see pages 75 and 81). The Logic Adapter and ways of using it in a course for Control are described in an MEP Control Technology Green File designed as a resource for the S.E.G. GCSE Syllabus in CDT: Technology.

540.315
CONTROL PATHWAYS LOGIC ADAPTER . . £12·40



MFA COMPUTER MODULE AS THE CENTRAL CONTROLLER

The idea of using the 'MFA' Computer Module as a central controller in more advanced control work was 'designed in' from the beginning. In the 'MICROELECTRONICS FOR ALL' course, simple digital microelectronic concepts such as logic gates, counting and timing, memory, input and output, were introduced. One of the end-points of the course is for the pupils to see that everything which can be performed in hardware (i.e. using connections between ICs on the boards) may also be performed in software. A simple microcomputer connected to the outside world via an interface board can receive input signals, give output instructions, and of course can perform logical decisions, count and time, as well as memorise information. The computer has greater power, speed and capacity than the simple hardwired systems offered by the 'MFA' boards. But the crucial difference is that the function of the device can be changed quickly by altering the instructions contained in the software. A solution in hardware can only be altered by changing the ICs used, other components and the connections between them. This is the real power of software engineering.

CFA—Control For All (see page 108)—is a set of extra resources which emphasises the control aspects of 'MFA' and which forms a natural link to the more advanced Control Pathways work.

The 'MFA' Computer Module is a simple interface board which has four input and four output lines on-board. The state of the inputs may be set by slide switches or by signals to the 2 mm sockets. Similarly, the state of the four output lines is indicated by LEDs, but may also be taken out from 2 mm sockets. The other boards in 'MFA' are connected by sliding them onto the bottom edge of the Computer Module in the usual way. This is only a very simple use of the Computer Module, however, because the two edge connectors give access to all eight input and eight output lines. Almost the whole range of 'Control Pathways' peripherals will plug into these edge connectors, so that the computer and its interface act as the 'central controller' for a complete and adaptable control system.

Particular features of the 'MFA' Computer Module:

widely available in schools with 'MFA'

clear board functions

suits a range of computers

compatible with 'Control Pathways' Peripherals

comprehensive course materials

The **'MFA' Computer Module** is available in a number of forms suitable for different computers; i.e. for the ACORN BBC B, B+ and Master 128 (connecting to the User and the Printer ports), for the RM 380/480Z (connecting to the User port) and for the Spectrum and ZX81. In this last case, the RM-compatible Computer Module is used with an intermediate Adaptor which plugs into the expansion port of the Spectrum and the ZX81.

NOTE: Those with RM Nimbus microcomputers fitted with the Nimbus PC Parallel I/O Port (available from RM as part 17587) will be able to use the BBC version of the Computer Module with their machine.

540.026
'MFA' COMPUTER MODULE
(for BBC Microcomputers) **£33·79**

540.029
'MFA' COMPUTER MODULE
(for RM 380/480Z) . . . . **£34·14**

540.010
'MFA' COMPUTER MODULE ADAPTER
(use with 540.009 for Sinclair Spectrum/ZX81) . **£25·65**

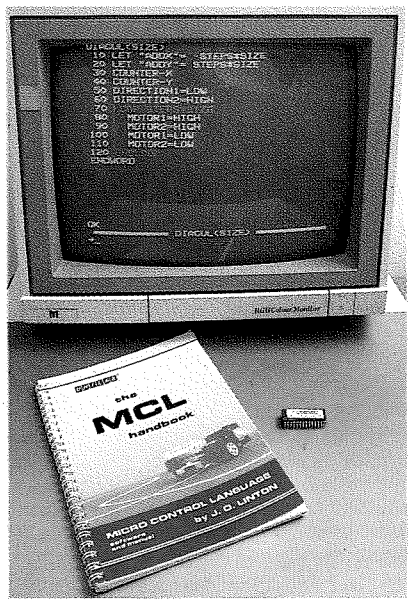
COMPUTER SOFTWARE FOR CONTROL PATHWAYS

Because of the way in which the Control Pathways publications have been structured, it is possible to use a variety of computers and languages to control an MFA Computer Module with attached peripherals. For example, Sinclair BASIC and RM BASIC can be used to write control programs, as can BBC BASIC, using the appropriate Mini-Manuals for guidance.

Other Mini-Manuals are available, however, which relate to other languages or language extensions. These have been specially developed to make control programs easier to write and to understand. CONTROL BASIC is an extension to the resident BASIC of a BBC Microcomputer. It is available direct from R.E.S.O.U.R.C.E. in Doncaster. A CONTROL LOGO extension is available from A.U.M.E., Hatfield, in versions for ACORNSOFT and LOGOTRON LOGOs for the BBC machine, LOGO on the RM380/480Z, and for LOGO on the Spectrum. The 'Control Logo' Mini-Manual, although it refers to the BBC computer throughout, in fact can be used with any of the A.U.M.E. Control Logo extensions.

MCL is a 'MICRO CONTROL LANGUAGE' in a ROM which is plugged into the BBC Microcomputer. It replaces the machine's resident BASIC by a language with many features specifically designed for Control. It is more fully described below.

MCL—MICRO CONTROL LANGUAGE



MCL is a powerful computer language for the BBC B, B+ and Master 128. It has been especially designed to be used in control situations, and for any device which uses the many input and output facilities of the BBC computer, including the User and Printer ports, as well as the ADVAL channels and the FIRE buttons. With MCL it is unnecessary to understand anything about the machine's operating system commands, or to know how to PEEK and POKE memory locations. There is even a facility which makes it easy to use binary arithmetic for reading or setting digital input and output lines. MCL is therefore particularly suitable for the beginner. Special features of MCL are:

develops structured programming skills

creates a dictionary of defined 'words'

many more looping and conditional techniques than BASIC

in 16K ROM for BBC Microcomputers, with 96-page manual

controls any device attached to the User, Printer and Analogue ports

Although MCL uses the same techniques for editing, loading and saving programs as BBC BASIC, the structure of the two languages is entirely different. An MCL program is constructed by defining new 'words' in terms of a basic vocabulary of reserved words which MCL always understands. At any time, new words may be tested to see if they work in the way they were intended. Once defined and tested, new words may be used just like MCL's own reserved words. It is also possible to define words so that they operate upon parameters which are passed to them. This means that a word can be very general; for example to TURN a vehicle through an angle (A). Then by specifying the angle, the same word can be used to cause the vehicle to turn through 10, 45, or 90 degrees, etc., by the statement TURN (10), TURN (45), TURN (90). (Words are not limited to just one parameter.) Words may be listed, renamed, copied, deleted, saved and loaded.

MCL does not have a GOTO statement. It does have a large variety of loop structures however. In addition to the normal FOR . . . STEP . . . NEXT and REPEAT . . . UNTIL statements, MCL also provides WHILE . . . ENDWHILE and LOOP (number) . . . ENDLOOP facilities, the usefulness of which is only appreciated when you return to using a language which does not have them. The variety of conditional statements is also much greater. As well as the normal IF . . . THEN . . . ELSE, Micro-Control Language also has a CASE structure which allows the program to test any number of conditions and to take appropriate action in each case. A second important conditional feature acts like an interrupt. In a setting-up procedure, the program can be told to perform a certain action (such as switching off all motors) WHENEVER a specified condition occurs (for example when a particular switch on an input line goes high). During the running of any part of the remainder of the program, the condition will be tested at the end of every program line. If the condition is found to be true, the specified action is taken, then the program continues from the next line.

Because MCL is structured in this way, the programmer is forced to take a much more logical approach to any problem. The problem must be broken down into smaller and smaller steps, until each step can be coded using words already known to MCL (either reserved words, or newly defined words). This top-down approach to programming exactly matches the method for designing a hardware project—a point which makes MCL an admirable language for Control.

532.060
MCL, ROM AND MANUAL
for BBC, B, B+, Master 128
only . . . . . **£28·00**