Bored with Buggies *or* New Ideas for Computer Control

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Ready to move on from building buggies? Tim Lewis and John Lee have a range of imaginative ideas for students, including animated baked beans cans and juke boxes

Computer-controlled buggies have served design and technology and science well for many years. However, a detailed analysis of the educational aims and objectives of their use in schemes of work does raise some interesting questions. Where does computer control fit into the philosophy of D&T? What does a typical computer-controlled buggy exercise hope to achieve in educational terms? Confirmation that these questions are realistic was reinforced by comments made in a school by a group of Year 9 pupils who had completed a six-week module of work programming buggies to follow various routes using commercially available software. Most pupils in the group said they liked the work at first but their final comment was: 'We don't know why we are doing it'.

Scrutiny of GCSE coursework projects reveals a paucity of work in this area and suggests a need to consider the effectiveness of computer control work at earlier stages in the D&T education of many pupils. It is pleasing to see that the new Design and Technology National Curriculum has control included at both KS3 and KS4 in the *Knowledge and Understanding* sections but surely the philosophy of D&T is such that it should be of some use in project work to be educationally viable?

Discussions with colleagues teaching D&T in schools revealed that they face several problems in trying to implement this type of work with larger teaching groups across an appropriate age range. The main problems appear to be:

— lack of computers

— lack of interface boxes

— software which takes a long time to become familiar with

— hardware with already limited availability frequently being tied up in individual project work for long periods of time.

Knowing the problems highlighted above, staff and students at Sheffield Hallam University have worked together to overcome some of the difficulties with a particular focus of providing teaching and learning opportunities for control at Key Stage 3. Initially the aim was to put computer control into a framework of designing and making activity so this D&T philosophy could be maintained as part of a computer control module. As work progressed the focus became to:

— resolve the problems of shortage of equipment

— provide interesting D&T activities which embrace computer control but also include design and make work

— plan work which can be delivered within the severe time constraints which often apply to D&T

— consider the effective management of a complete computer control module in a way that ensures that *all* pupils are kept busy with meaningful D&T tasks.

These aims were realised by:

— developing a computer control kit to be used by pupils in project work, but retrievable for use by other pupils

— exploring the use of a range of output devices to be incorporated in the kit

— exploring the use of less resistant materials for use in computer control projects to facilitate rapid assembly of design ideas

— using commercially available software suitable for the age phase which can be learned quickly so results can be obtained with the minimum of problems

— developing design activities which motivate pupils by providing interesting ways of using computer control.

The following outlines some of the ideas which have been developed.

■ The Key Stage 3 Kit

Several kits are required, each kit consisting of an interface and a range of output devices.

The computer interface

This 'Economy' interface has been designed to provide a cheap output-only interface which can be incorporated in pupil project work and as such, it is the most basic of interfaces. The interface is designed to connect to the 'user port' of Archimedes, BBC Master or BBC model B computers. This can normally be configured to receive/transmit any combination of input/output signals. However, in the interests of simplicity for KS 3 work this provides 'output' only.

This well established circuit consists of an integrated circuit with eight Darlington drivers, one for each of the computer output lines available at the user port. Each channel of the chip is able to carry up to 550 mA and is controlled by the output of the computer user

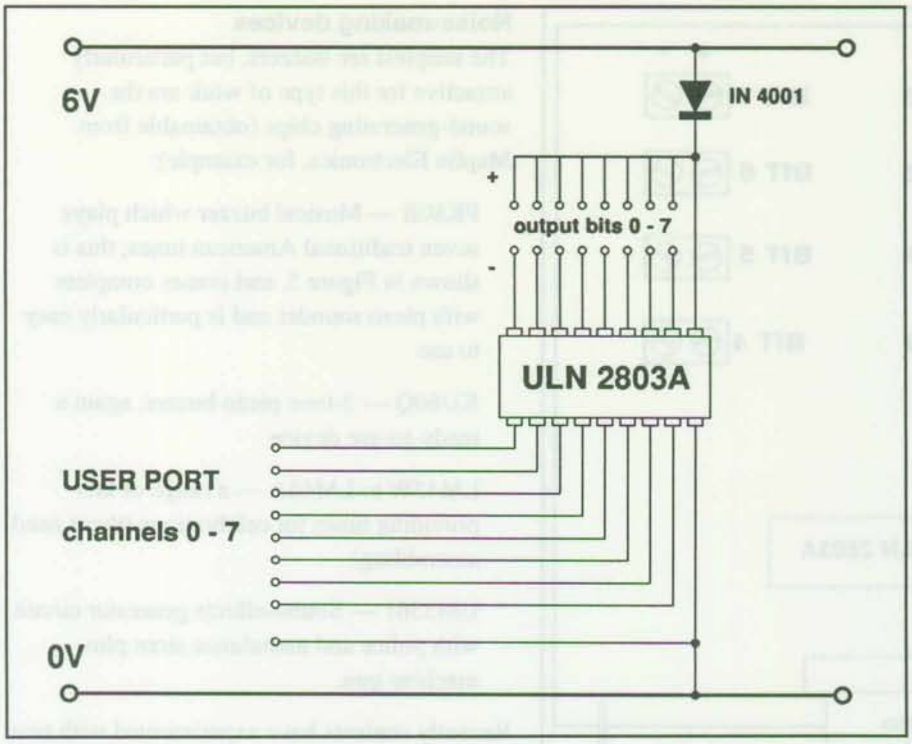
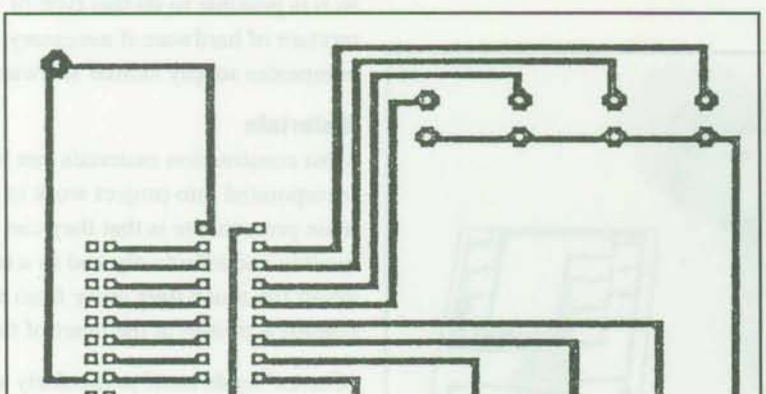


Fig. 1: Circuit diagram of the Interface

port, which has a very limited current carrying capacity. The chip acts as a current 'sink' rather than 'source', meaning that the current flows from the positive supply to 0 V through the chip. As a result, any polarised component such as a light emitting diode (LED) must have its positive terminal connected to the supply and its negative terminal connected to the chip.

The circuit diagram of the interface is shown in Figure 1, the track side of the printed circuit board (PCB) mask in Figure 2, the layout of the board in Figure 3 and the completed board in Figure 4. The circuit is constructed on half a Eurocard PCB. The board is drilled using a 1 mm drill for the chip holder and ribbon cable header and a 1.5 mm drill for the screw

Fig. 2: PCB mask



terminal connector pins. Solder the chip holder and diode onto the board (note the polarity of the diode), attach both the 20-way insulation displacement connector (IDC) header and the 20-way IDC socket to the 20-way ribbon cable, taking care to line up the arrow on the socket with the red tracer on the cable and the red tracer to the left-hand side of the board. The power source used can be a 6 volt lantern battery. The IN4001 diode on the board reduces the voltage to slightly over 5 volts, making the interface safe to use with the computer. It also provides protection for the interface should a pupil inadvertently connect the battery up incorrectly. We soldered leads to the boards with red and black crocodile clips to connect to the battery. Using battery power avoids problems associated with power supplies such as setting the wrong voltage.

Output devices

A range of output devices is shown in Figure 5 and includes:

Light Emitting Diodes (LEDs)

A selection of colours can be provided in the kit, the super bright or high-intensity variety being the most suitable. These are pre-assembled with the series resistor (220 ohms) soldered to the lead plus extension wires coded red and black. This was then made more durable by covering it with heat-shrink sleeving.

Light bulbs

Bulb holders with 4.5 volt bulbs are most suitable.

Motors

Small 3-4.5 volt motors work well although this interface only allows them to be turned on and off. The problem of them running too quickly to be of real use in project work has recently been overcome by D&T suppliers (Hindleys, for example) marketing motor/gearbox kits which provide a range of speeds. The cost is around 3.75 for a motor, side frames, axles, ten gears, all nuts bolts and spacers plus instructions to make up the gearbox.

Solenoids

An example is shown in Figure 5. It is a point motor solenoid used by model railway enthusiasts, and is available from model shops. Although these devices are designed to work on 12 volts they work adequately on the 5 volts available from the interface. We used the version which does not incorporate a switch, so

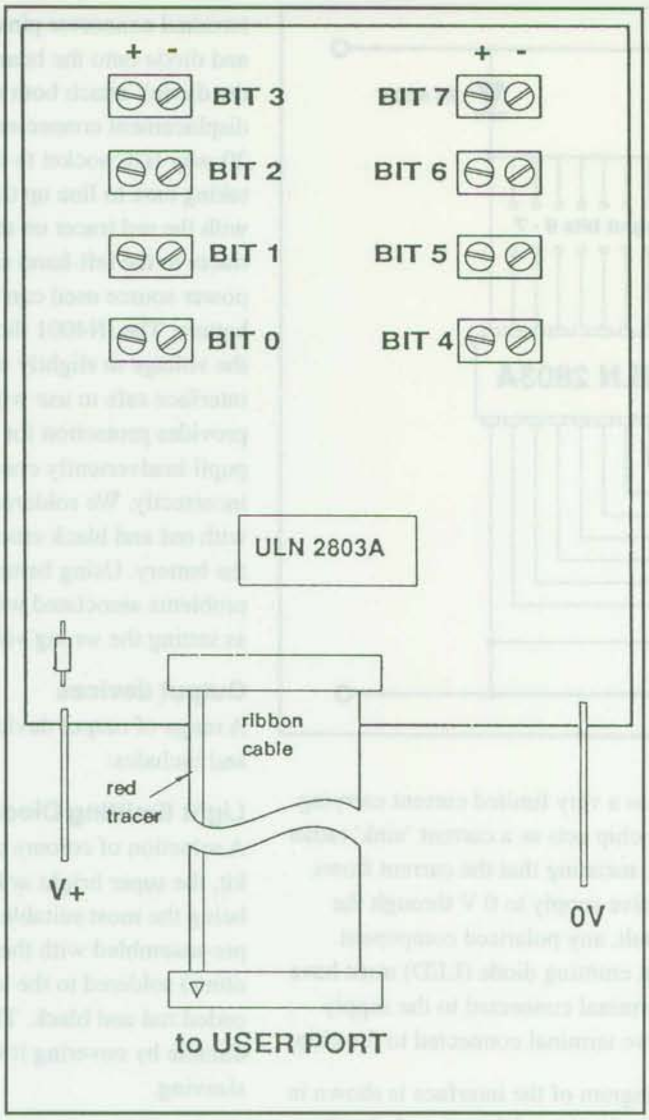


Fig. 3: Layout of the interface

that two control channels are needed to move it firstly in one direction and then back. An output pulse of 0.2 of a second switches the solenoid. These are useful for pop-up actions although the range of movement is limited to about 8 mm.

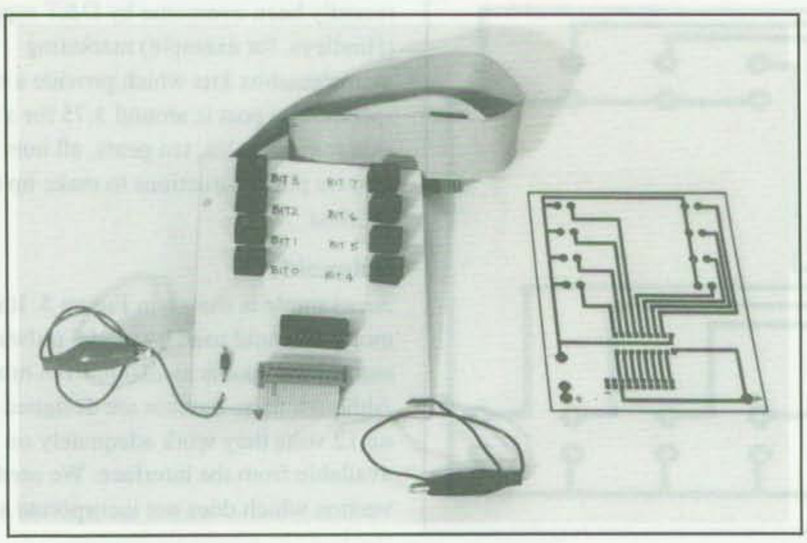


Fig. 4: Completed 'Economy' interface

Noise-making devices

The simplest are buzzers, but particularly attractive for this type of work are the sound-generating chips (obtainable from Maplin Electronics, for example):

FK80B — Musical buzzer which plays seven traditional American tunes; this is shown in Figure 5, and comes complete with piezo sounder and is particularly easy to use

KU60Q — 3-tone piezo buzzer, again a ready-to-use device

LM43W to LM46A — a range of kits providing tunes for celebrations (these need assembling)

UM3561 — Sound-effects generator circuit with police and ambulance siren plus machine gun.

Recently students have experimented with two new sound-generation chips from Maplin's:

AEllM — American Western sounds such as bugle fanfare, horse neigh and pistol shot

AE12N — Animal and farmyard sounds such as elephant, frog, pig and cow.

For use in the Key Stage 3 kit these would need to be assembled onto PCBs or stripboard prior to use with the interface, but they do provide an attractive range of sounds worth experimenting with for use in control projects.

The software

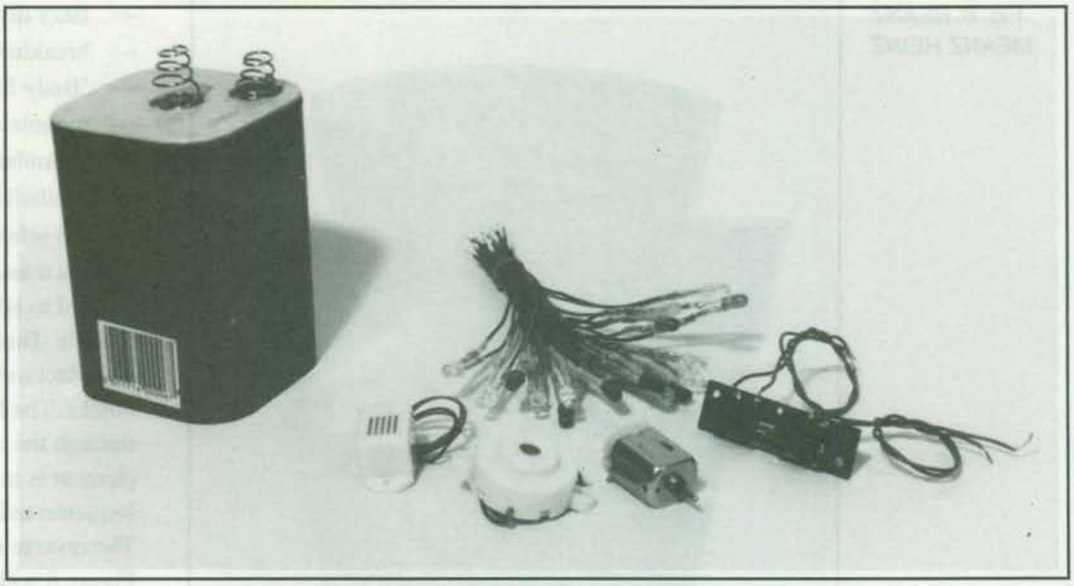
For KS3 control project work we have found CONTROL-IT from The Resource Centre particularly suitable. Versions of the software are available for both BBC and Archimedes computers. They are very similar in operation so it is possible to do this type of work with a mixture of hardware if necessary. Other companies supply similar software.

Materials

Most construction materials can be incorporated into project work of this kind. The main prerequisite is that they can be worked quickly and effectively and as a result, do not divert too much time away from the computer control activities at the heart of the project.

'Correx' lends itself particularly well to this type of work. It cuts easily using modelling knives or scissors and joining is straight-forward using brass bifurcated paper clips. Double-sided tape can also be used as long as

Fig. 5: Output devices



the joint is not put under undue stress. For applications requiring greater strength, good results have been achieved using the adhesive normally used to join plastic waste pipe (care is needed, however, as this is 'sniffable').

Thin polystyrene sheet which can be cut with scissors or knife is also useful as are a range of MDF blocks which can be glued together to support structures.

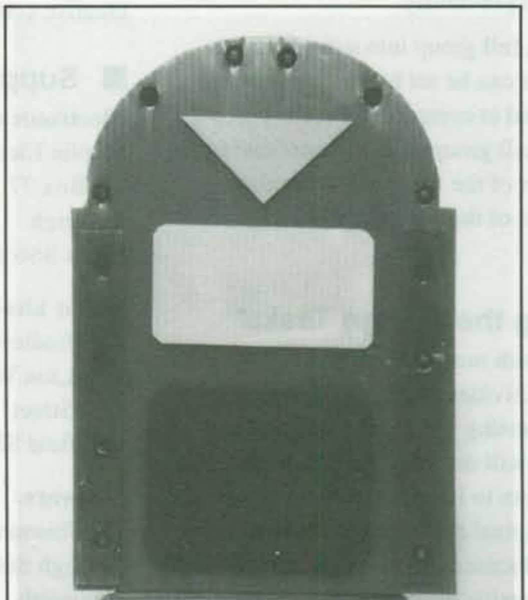
■ Management of project work

Since one of the main objectives for this development work is to use computer control in projects, the efficient management of pupil activities is essential if success is to be achieved. Initially tasks need to be set to overcome some of the problems of equipment shortage, such as:

— learning to use the control software

— connecting different output devices to the interface to explore their uses

Fig. 6: The Juke Box
Fig. 7: Reverse side of the Juke Box



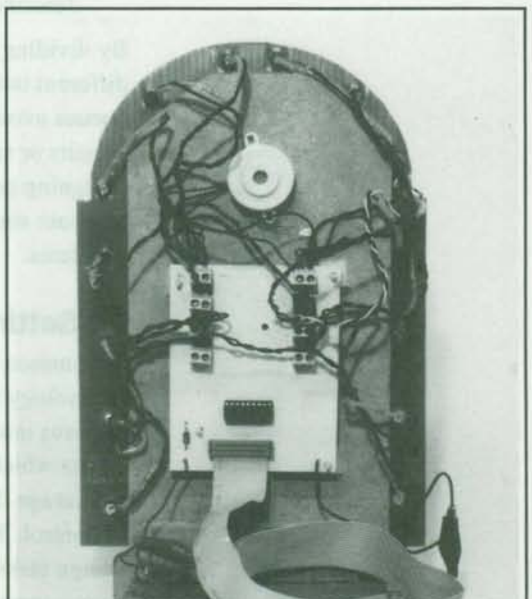


Fig. 8: BEANZ MEANZ HEINZ

— initial design work for a product which uses computer control

— planning a set of control instructions to be used for the proposed product

— designing the product and experimenting with materials

— making the product using the materials described previously.

By dividing a full group into sub-groups, different tasks can be set for each lesson and queues avoided at computers. Pupils working in pairs or small groups can be beneficial to the designing part of the work but it can also alleviate some of the equipment shortage problems.

Setting the Design Tasks

In common with most school-based design and technology activities, this type of work requires interesting and challenging starting points which will motivate the pupils and thus encourage them to learn more about computers in control. Typical applications could include design tasks focused on 'point of sale' displays or commemorative 'dioramas'.

Advertising provides many opportunities for 'animated' displays in the Blackpool lights tradition, for example;

— fizzy drinks such as Coca-cola
— breakfast cereals
— 'Body Shop' products
— mountain bikes
— Wimbledon tennis
— football matches
— the school logo.

Figures 6 and 7 show a juke box which could be used to advertise 1960s 'Golden Oldies' records. This is KS3 level work and is manufactured using correx supported by MDF blocks. The LEDs are set in holes punched through the correx. The computer control element is to control the LEDs to work in a sequence and at appropriate points, play a tune. The reverse side of this project is shown in Figure 6 with the LEDs and a Maplin American tune player (FK80B) connected to the interface. There can be a considerable variety in the programming sequences to give interesting effects.

Figure 8 shows an example produced by one of the university students as part of the development work. It is an advertisement for beans in which the bean can rotates and spills out the beans which then spell out in sequence BEANZ MEANZ HEINZ, using super bright orange LEDs.

As with most D&T activities, choose the theme or topic well and pupils will respond with interesting ideas, providing opportunities for creative computer control for everyone.

Suppliers

Electronic components:
Maplin Electronic Supplies
PO Box 77
Rayleigh
Essex SS6 8LU

Motor kits and Correx:
J B Hindley Ltd
26B Lion Works
Ball Street
Sheffield S3 8DB

Software:
The Resource Centre
51 High Street
Kegworth
Derbyshire DE74 2DA