Bit by Bit versus computer control

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Abstract

Change provides excitement of new challenges for the design and technology teaching profession. New technology, materials and resources provide our profession with the stimulus for change, therefore at Sheffield Hallam University we provide students with the opportunities to evaluate and compare new products with the focus of using them in their teaching. The implementation of the new GCSE design and technology syllabuses has recently provided a further impetus to this work of research and evaluation for the design and technology student teacher. This article is about teaching one aspect of the new Systems and Control GCSE syllabuses using either conventional computer control, already established in many schools, or the more recently introduced Technology Enhancement Programme's (TEP) Bit by Bit controller. Examples of projects developed for Key Stage 4 teaching are used to illustrate how the work progressed together with extracts from the students' evaluations and their conclusions.

One of the most exciting aspects of design and technology must be the constant change brought about by technological advances which give us new materials, processes, hardware, software and teaching resources. Coupled to this is the development of the National Curriculum and new examination syllabuses: the result is a busy life for the design and technology teacher. Design and technology teachers are regularly involved in assessing products and making judgements about how a new resource can be integrated into schemes of work. At Sheffield Hallam University professional year students are given the opportunity to evaluate current design and technology examination syllabuses from the different examination boards. This has been particularly interesting during recent years as the boards have been preparing and publishing their new syllabuses to be examined in 1998.

During the last academic year several students opted to work in the area of systems and control by analysing the syllabuses and building up their expertise to enable them to teach this when in their first post in schools. The focus of the group's work was microprocessor control using a range of software and hardware found in schools such as Control IT with simple interfaces, SMART MOVE and SMARTBOX from Economatics on both Archimedes computers and PCs. Surprisingly the syllabuses do not include any mention of programmable logic controllers yet the Technology Enhancement Programme (TEP) Bit by Bit controller is readily available for use in schools. The group decided to compare the Bit by Bit controller with microprocessor control using the scenario of a Key Stage 4 project.

The project selected was the design, manufacture and control of a shop window display which would be used in a travel agent's window to promote holidays in America. The task set was for the students to design and make the display in such a way that it could be controlled using computer control with appropriate interface and software or the TEP Bit by Bit controller. Students had to compare the two methods of control using the following criteria:

- suitability for use at Key Stage 4
- effectiveness of the control system
- reliability and ease of use from the teacher's point of view
- opportunities offered by the system.

The Economatics SMART system is well established in schools and is available for use with PCs, Archimedes, BBC Master or Apple Mac computers. The system has been used by students over a number of years and has been reliable. The SMART MOVE software is similar to Control IT from Resource using simple commands and the opportunity to build up a control program using simple procedures as building blocks. Economatics have now developed LOGICATOR, which is a more advanced piece of software.

The TEP Bit by Bit controller is a printed circuit board with a PIC controller programmed to provide 64 lines of eight bit code. It is programmed by using switches to set each bit high or low as is required. Data

is entered into memory using a push button switch. When in the 'run' mode the programme is controlled by an on-board clock. Interrupt and reset facilities are available and the speed a program runs can be altered by adjusting an on board potentiometer. The controller automatically detects the program end. The board has provision for relays and their driver transistors to be added; these are available as a kit from TEP. The whole system is battery powered by four AA sized batteries.

Ten students were involved in this evaluation exercise. The following are illustrations of the displays developed by four of the students with a short description of the functions. The programming of these displays can be at a very simple level, or far more complex depending on the ability of the pupil. Also, as the displays incorporate several functions each function can be programmed in turn, tested and then integrated into a final version.

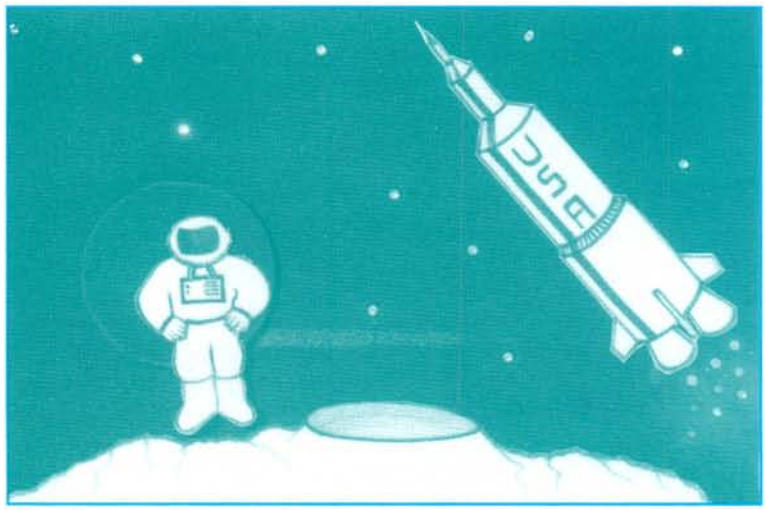
American Airlines is a display of the view from an aeroplane cockpit as it approaches the runway, a series of super bright LEDs on the background simulate the runway landing lights and can be programmed in sequences which give the illusion of the aircraft approaching the runway. The foreground illustrates the interior of the cockpit, this is pivoted so it can rock from side to side driven by a motor/gearbox and cam mechanism. The programming task is to simulate the aircraft approaching the run way by speeding up the LED light sequence and at the same time move the cockpit gently as if under pilot control. The display is manufactured in foam centred model board with the detail of the cockpit on black sugar paper done in white crayon.

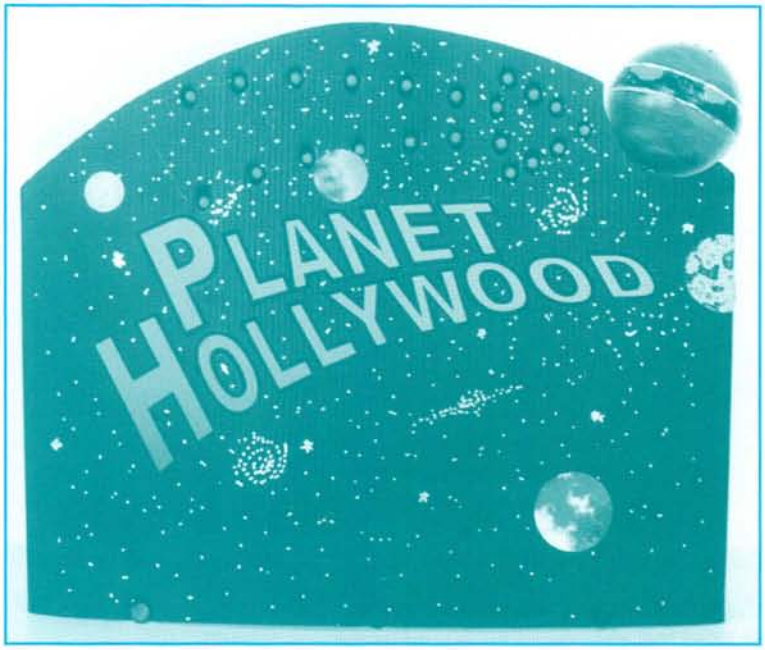
The aim of USA Take off is to promote American holidays by using the American successes in space exploration. It consists of an MDF backboard which is covered with black plastazote to give the effect of a soft dark sky of a planet, this has several super bright LEDs to represent stars, these can be programmed to twinkle. The rocket is made of card and is provided with a 'flame' made of orange and red LEDs which can be programmed to flicker. The space man is mounted on a disc which is rotated by a small motor/gearbox unit, he is pivoted at his head and weighted at his feet so as the disc rotates he can be made to 'bounce' up and down and 'jump' sideways. This simulates him 'leaping' across the planet surface and is achieved by starting, stopping and reversing the motor in short bursts.

American Airlines
Rick Hampson

Planet Hollywood is a correx construction with a motor driven rotating planet and a series of super bright LEDs set in the form of an arrow. Computer graphic software has been used to produce high quality text and illustrations of the planets. The LEDs in the display turn on in a selection of sequences with the planet rotating when the arrow is fully lit. Additionally a Maplin Electronics American tune player is turned on periodically and stepped through its sequence of tunes.

USA Take off
Alix McTaminey





Planet Hollywood
Gordon Crosby

Hollywood is a complex display with motor driven moving models, super bright LEDs and low voltage high power light bulbs. The 'head' of the robot rotates, driven by a small motor/gearbox unit, the LEDs are sequenced to illustrate the flying saucer vapour trail and the whole set is lit in sequence by the 'stage' lighting consisting of three light bulbs hidden behind the American flag edging to the 'stage'. A variety of materials were used including MDF, model board and clay. The TEP Bit by Bit controller can be seen connected to the display.

All the displays used manufacturing techniques which are well within the capabilities of Key Stage 4 pupils. A particular consideration was the use of easily worked materials so manufacturing time was kept to a minimum so when the project is implemented in schools pupils have time to concentrate on the control aspects of the work. For the purposes of this evaluation each display was fitted with a screw terminal connection block so it could be connected to a computer control system or the TEP Bit by Bit controller. Students were then able to program their display using both systems. Several students took their displays to their placement school so pupils could do a similar evaluation.

Hollywood
Joanne Whitham

Conclusions

This project finished with a seminar to identify strengths and weaknesses of each system. The focus was implementing the project in school using either computer control or the TEP Bit by Bit controller.

The main issues identified were:

- the project has considerable potential in school providing the materials are available, particularly the LEDs, motors/gearbox units etc., although there was view that many of the components could be recovered and reused by other pupils if necessary

- the SMART BOX and SMART MOVE worked well, but seemed over complicated for this project and all students identified that their placement schools did not have enough computers or SMART BOXES, therefore management of the project would be difficult, also students considered 'plugging in' at the start of each lesson could be time consuming

- the TEP Bit by Bit controller worked well although a small number of students considered that vulnerability to misuse was a problem. A particular difficulty seemed to be the battery connections a suggested improvement being the battery pack permanently attached to the board

- the SMART system provides lots of facilities for pupils to use, particularly ambitious more able pupils

Extracts from student evaluations

TEP Bit by Bit Controller

The TEP controller is a self-contained device with facilities to store up to 64 lines of eight bit code in its own memory. The controller does not use a programming language as the instructions are entered directly using DIP switches in logical, sequential steps.

The Bit-by-Bit Controller is an excellent innovation in the field of systems and control technology, it is extremely cheap, light and small, making acquisition, storage and portage easy. Its reliance on a 6 volt supply and portability means that it can be used in a wide variety of teaching environments, Furthermore, its cost and size make it potentially ideal for inclusion in GCSE projects.

The device is easy to program and pupils at Key Stage 4 find it easy to work with. They are able to spend time applying their skills to making devices which can be controlled by the device. One of the greatest assets of the controller is it gives children 'ownership' of their project as they can have one each due to its low cost.

The TEP board comes into its own on account of its affordability and ease of use. The controller can be mounted in a project and it does not require an external power source. The simplicity of the programming means that pupils can concentrate on how to utilise it rather than getting embroiled with the complexities of programming and debugging, a very time consuming task.

The reliability of the TEP device has yet to be proven, there are some doubts about its robustness for use in the school workshop. The DIP switches are likely to cause problems as they are very small. The battery snaps are poor quality, failure causing the program to be lost from the memory.

Simple to program with rapid results, this results in a high level of pupil motivation. The literature is easy to understand. The possibility of adding relays etc. provides opportunity for pupils to develop their control skills in a practical way.

All the programming is done on the board whereas other systems need a monitor, keyboard and interface.

The system offers a design and technology department the opportunity to introduce control work at low cost yet gives the opportunity for pupils to get good results.

Computer control with Control IT or SMART Move

This system will allow up to eight inputs or outputs to be used for control purposes, more connections are possible using the analogue port. The software is a variation of BBC Basic which is a fairly sophisticated language.

The computer control set up can cope with a far greater degree of flexibility such as loops, these are not available on the TEP controller.

The SMART MOVE system is very suitable for Key Stage 4 work as it allows a variety of actions to take place at the same time, such as reading inputs and giving an output. The TEP controller has limited inputs. As well as allowing pupils to control LEDs, motors and light bulbs the system also has analogue and digital inputs which means a variety of sensors can be attached. Complicated programs can be broken down into smaller components making programming easy. As programs can be saved on a disk sophisticated programs can be written and tested over a period of time.

I found the motor control on the SMART BOX useful as my display needed a motor which rotated slowly. It was necessary to use a gearbox with my motor when I controlled the display with the TEP controller as I could only turn it on or off.

The combination of the computer and the SMART box is quite easy to use, but pupils have to learn about programming before they can obtain results. This means that from a teachers point of view more time will be needed to teach programming skills before pupils can apply their knowledge to project work.

Computer control programs provide an insight into control systems such as input, process and output. This system has helpful error messages for when things go wrong. It is easy to provide differentiation with this set-up as more able pupils can explore the programming language and get sophisticated results and less able pupils can produce simple programs and get a result.

- pupils in school found the Bit by Bit controller very easy to program whereas time was needed to develop programming expertise with SMART BOX, even when tried with the more up to date LOGICATOR software available from Economatics

- the Bit by Bit is easy to experiment with, particularly in a project such as this where the programs need to be changed quickly to see the effect

- both systems offered the opportunity to set homework but planning Bit by Bit truth tables seemed more attractive than trying to work out a sequence of commands for SMART MOVE

- as the Bit by Bit has its own power supply it can be used in any workshop, or even taken home to be programmed

- there was a view that the Bit by Bit controller could be used by Y7 pupils in simple projects and this could lead to more complicated work at Y9 and 10 using either system, this could ease some of the problems of lack of equipment

- all students considered that the cost of the Bit by Bit, particularly with the relays added, was its real strong point as it provided opportunity for a teacher to run systems and control with a full group of pupils with minimum classroom management problems.

Syllabuses

GCSE syllabuses used in this project:

Northern Examinations and Assessment Board (NEAB): Systems and Control Technology from:

NEAB
Wheatfield Road
Westerhope
Newcastle upon Tyne
NE5 5JZ.

Southern Examining Group (SEG): Systems and Control Products from:

SEG
Publications Dept
Stag Hill House
Guildford
Surrey
GU2 5XJ.

Midland Examining Group (MEG): Systems and Control from:

Midland Examining Group
East Midland Office
Robins Wood House
Robins Wood Road
Aspley,
Nottingham,
NG8 3NR

Resources

SMART BOX, SMART MOVE and LOGICATOR are available from:

Economatics (Education) Ltd.
Epic House
Darnall Road
Attercliffe
Sheffield
S9 5AA

The TEP Bit by Bit Controller, motor/gearbox units etc are available from:

Fiona Watts
Middlesex University
E block
Bramley Road
Oakwood
London
N14 4YZ

Plastazote, Foamex, Corex, Model board, motor/gearbox units etc are available from:

Hindleys
Lion Works
Ball Street
Sheffield
S3 8DB