Control Technology — from the beginning

Michèle Linehan-Hill

Dept of Educational Studies
University of Surrey

What is control technology? Why do it in school? Where do you start? How should Control progress through the key stages? Here Michèle Linehan-Hill, who has run many training days in Control Technology, offers some suggestions

This article is aimed at the many teachers to whom Control Technology is a new and developing area: primary teachers aiming to provide pupils with their first experiences of Control, secondary teachers involved in development at Key Stages 3 and 4 and indeed, any teachers looking for an overview of Control across all the key stages.

What is Control Technology?

The term control technology has emerged in education without a clear definition of what it encompasses. Even the various National Curriculum documents relating to Design and Technology and Information Technology do not provide a ready definition of what constitutes control technology in schools. Taking a broad view, it can include any system designed to operate or perform a task in a set fashion, which may include responding to some external input.

This area of technology education has evolved over recent years, rather than having been planned, and developments in equipment and software have often led to developments in the curriculum. Imagine for example, how different the current scene would be had Seymour Papert not invented Logo.

What follows is my own view of control technology:

> Control implies something to be controlled, i.e. there must be one or more outputs — a motor, a heater, a loudspeaker, movement of a piston etc. Then there must be some system which has been designed to control the output. There are two distinct means of control: a) a sequence of instructions via a computer program, or b) a response to some external input such as temperature, light, pressure or moisture level. Some systems use both means of controlling the output.

In this article I consider computer control specifically, whilst bearing in mind that other aspects of the curriculum (electronics and pneumatics, for example) also include aspects of control technology.

Why do it in school?

There are two major reasons:

- Because it is there in the world outside. If school is to help prepare young people for their adult life, education should reflect the changing society. So technology education in particular must reflect the changes in technology, in order to equip pupils with relevant experience.
- It encourages self development and improved skills. With no set solution to a given problem, control activities always involve pupils in problem solving. Learning to use control software develops logical thinking and teaches pupils the basics of computer programming.

What you need for computer control

This section gives an overview of software and hardware currently available to support control technology in the classroom. Whilst it is by no means comprehensive, it aims to give a picture of some of the options most widely used in schools, and may encourage teachers to find out more.

Logo, turtles and others

My starting point with Logo would be a programmable toy such as the Roamer, which pupils can instruct using pressure-sensitive keys to move forwards, backwards, turn or make sounds. Powered by batteries, they are used in most primary schools at Key Stages 1 and 2, and although they are still very relevant at Key Stage 3, few secondary school teachers are familiar with them. The full potential of the Roamer is rarely exploited at primary level and the facilities to use repeats and define procedures could be used well by older pupils.

Children have few problems transferring from the Roamer to working with Logo on the computer; some schools link a floor turtle to the computer to mimic the patterns produced on screen. Progression from the Roamer to Logo enables pupils to see their commands on the screen and to edit and store the programs they have written.

Control boxes: hardware

Control boxes provide the interface between the computer and the inputs (switches and sensors) and outputs (motors, buzzers, lights, etc.). They also act as a buffer to protect the computer as well as providing the necessary power for the outputs.

The simplest and least expensive systems, which generally only allow digital inputs (i.e. switches but not sensors), and usually require a BBC-style user port for connection, include the TTS box, the Commotion box and the Lego Interface A. Apart from the Lego Interface A (which allows a maximum of two inputs and six outputs), the others are all 8 input 8 output boxes.

The use of computers in schools is moving away from the BBC towards IBM-compatible PCs, the RISCOS-based Acorn computers and also Apple Macs. Control boxes which connect to the serial port of all these computers, are coming onto the market. The Smart box, perhaps the most versatile system currently available, has a number of additional features. Up to four analogue sensors (such as temperature and sound) can be connected as well as the 8 digital inputs and 8 outputs. This means the system can also be used for data logging (as part of a science investigation for example). The new Lego system Controlab comes as a complete package: interface, inputs (analogue and digital), outputs, Lego kit for seven models, software and work cards. It is available for PCs and Apple Mac computers. Teachers looking for a ready-made control technology course will welcome this system. The support material is clear and will suit teachers who are new to control. It does, however, lack the flexibility and versatility of the Smart box, for example, and does not lend itself to control of pupils' own models other than Lego kits.

Control boxes: software

Most control software is based on the programming language Logo, which means that pupils can easily transfer their programming skills to it. Some versions of Logo offer very similar control versions, for example RM Logo has a control version, Controller. Two RISCOS-based programs, CoCo and Contact, provide very user-friendly mouse-driven versions, again based on Logo.

There are a number of non-Logo based programs, notably Logicator which runs under Windows and is based on design through flowcharts. This gives an emphasis which is less on programming and more on designing the control system. The flowchart also gives a clearer graphical representation of the process.

Progression in control

When looking at progression it is useful to consider an individual pupil and the experiences he or she might have from age 5 to 16. It is particularly important in a new and developing area to plan progression from primary through to secondary. As computer control in schools has developed in rather a piecemeal way it is possible to find more sophisticated control work happening in a primary school at Key Stage 2 than in a neighbouring secondary school at Key Stage 3. Up to now much has depended on the interest and enthusiasm of individual teachers. I believe the time has come for schools to start

getting together to come up with a plan for progression.

Below I put forward a possible model for progression working on the basis of some experience of control work for each year group. Schools will obviously have their own sets of constraints and opportunities but my suggested model could act as a basis for discussion.

Pupils begin in Year 1 with a pre-Logo sequencing activity, go on to learn how to control the Roamer and use the Logo software and progress to include the use of repeats and procedures. Before leaving the primary school they have the opportunity of simple computer control of a number of outputs using a control box. At secondary level, pupils develop their skills to include using digital then analogue inputs along with experience of control using electronics. They are then well equipped with the skills and experience necessary to evaluate and decide which system to use in their GCSE control project.

Year 1: Sequencing (pre-Logo activity)
For example, putting in order the stages in making a cup of tea or getting washed and dressed in the morning.

Year 2: Introduction to the Roamer
For example, driving Roamer around an obstacle course in the classroom.

Year 3: Introduction to Logo on screen
For example, negotiating a maze (drawn on an overhead projector sheet placed over the screen).

Year 4: Investigate shapes using the Roamer with pen attached; introduce the use of repeats in drawing squares, hexagons, triangles etc.

Year 5: Logo projects
For example, creating more complex patterns or drawing a house using procedures for the roof, windows, door etc.

Year 6: Simple control box project using the TTS Control box
For example, design an advertising display with 3 or 4 bulbs programmed to flash in sequence.

Year 7: Using Lego Interface A and Legologo (building on pupils' previous experience of Logo), controlling Lego models which include a digital input (e.g. a micro switch on the front of a buggy).

Year 8: Non computer control control using digital electronics
For example Microelectronics For All (MFA).

Year 9: Use of Smart box using Windows software Logicator, possibly including the use of construction kit models, but making use of analogue as well as digital inputs.

Years 10 and 11: GCSE project designing and making a working model with inputs and outputs and choosing MFA, Lego Interface A or Smart box to design a control system for the model.

Hurdles to overcome

Why, when there is so much discussion and interest in control technology in education, do very few schools feel they are providing adequate provision for pupils? I would suggest two major factors:

Resource implications and practicalities

Two control boxes with software, a few sensors and a few outputs can easily cost £500. This would be adequate for a couple of small groups of pupils working on a project but is hardly going to be sufficient to provide a control course for a year group of 100 pupils. A commitment by school management to the required financial outlay is essential.

Ready access to computer hardware can also be a problem in many technology departments, along with the storage and movement of equipment.

Teachers' lack of knowledge and confidence

The hardware and software available for control is continually developing, along with the trend towards more powerful computers. There is an increasing number of options for control on the market and very few teachers have sufficient time or the means available to familiarise themselves with what is out there in order to evaluate and decide on what systems to purchase. Furthermore, technology teachers who are not confident about the way they want to move forward in computer control may find it difficult to convince school management to give the necessary financial backing. Practical hands-on in-service training is essential and perhaps the only way in which technology teachers will gain the overview and confidence required to help their pupils explore the full potential of control technology.

References

The Roamer is available from Valiant Technology

RM Logo and Controller (for Nimbus computers) are available from Research Machines Plc

Logotron Logo (for Acorn Computers) is available from Longman Logotron

TTS Control Box is manufactured by Technology Teaching Systems Ltd

Commotion Control Box and CoCo are available from Commotion

Lego Interface A and Controlab are available from Lego Dacta, Lego UK Ltd

The Smart Box and Logicator are available from Economatics Education Ltd

Contact is available from Educational Electronics

Microelectronics for All (MFA) is available from Unilab Ltd