The Control Box — just another tool?

Rob Cottom

Dept of Design Technology Eckington School, North-east Derbyshire

Rob Cottom describes how the use of a computer, interface and temperature sensors has made a stove designing project both more safe and more exciting

For several years we have used the Smart Box to successfully demonstrate control through various modular activities. However, our latest use of it has been as an effective tool enhancing an existing project whilst replacing an unreliable and often unsafe practice.

For the past three years we have run a successful *Stoves* project with our Year 7 classes. This has involved each of the pupils being set the design brief 'I am going to design and make a stove'. The context and situation have been for them to decide in as imaginative way as they like. The subsequent specification was mainly predetermined for them and centred around the solution being a collapsible device able to be carried in a rucksack. The purpose of the stove is to boil a mug full of water in under eight minutes so as to make a hot drink of coffee/soup/chocolate or whatever, in the situation they have specified.

The fuel for the device initially started as a firelighter segment. However, problems of smoke, tainting and uniformity of block across all tests led us to use a measured amount of methylated spirits housed in a cut-down tin can of 10 millimetre depth. Although criticism could be made of both the tin can and the meths as not being appropriate for the situation and the specification, the easy availability of both of these to a year group of 280 was a significant factor in choosing them.

■ Analysis and investigation

The pupils are called upon to do some research into existing products for boiling water on and to comment on the effectiveness and suitability of these with regard to the specification. Typical examples are the camping-style stoves which run on an assortment of different fuels. They are then introduced to the Trangia-style stove as used by the forces. The Trangia is demonstrated for them and tested using the same equipment with which they will later test their own outcome. The result of this test is kept so that they can compare it with their own at a later date.

Some sketching of basic ideas is then followed by them modelling their idea in card and visually testing it for fit around the tin can, its ability to hold the saucepan, and stability. Other influences are also discussed such as the path of the flames and the ability of air to flow to the flame, with modifications being made along the way.

The stove is then constructed out of aluminium using all of the basic marking and cutting tools, with extra demonstrations tailored to suit the design requirements of certain pupils such as the use of folding bars or the pop-rivet gun.

On completion of their device they then test it in the same way that they saw the Trangia tested at the start of the project. In the first three years of us doing this project, the rising temperature of the water over the eight minutes was recorded with pen and paper using a thermometer and stop-watch. With the temperature being taken every 30 seconds in a workshop with 20 pupils, it caused us some anxiety with regard to safety. The opportunity for knocking over boiling water, spilling meths near stoves already alight and the frequent breaking of thermometers were the main cause of this unease. After the testing, the pupils then put their results into a software package called Presenter, from which they were provided with a print-out of their graph.

■ Improved testing

The system we are using this year utilises a Smart Box interface coupled to an Archimedes A3020 with up to four temperature sensors connected to the interface. The program, written in Smart Move, was initially written to take one set of results at a time. This proved in practice to be far too time consuming, allowing only four or so pupils per lesson to test their design. Although there was the opportunity to use up to six Smart Boxes, the problem of freeing another five computers and housing them within the workshop where other pupils were still working on the practical element of the project was totally out of the question. Instead, I rewrote the program to record the results from one, two, three or four stoves at once, using four separate temperature sensors, each connected to an analogue sensor port on the one Smart Box. With a little inventiveness using a retort stand and a home-made structure to support the sensors over each stove, the computer was able to record up to four sets of results at once whilst keeping them as separate files.

The pupils have easily assumed a team approach to testing whilst still keeping ownership of their own results. The team responsibilities are split into being in charge of lighting all of the stoves with a spill, filling the saucepans with the correct amount of water, dealing with the boiled water at the end and

running the program at the correct point. This revised approach has proved to be a far safer and effective method of testing.

During testing the pupils have to record the temperature (in their booklets) using the screen-displayed clock to count off each thirty seconds and the appropriate display sensor to record the water temperature. The data which is being recorded for each sensor automatically saves itself as a series of CSV files at the end of the eight-minute test. The files are saved on one of the two Stove data disks, each CSV file being entitled with a tester's name. The program then resets itself, ready for the next four pupils to begin their test.

The pupil can then transfer to another computer either in the workshop or in a nearby classroom. Armed with his or her CSV file on the data disk, he or she can now enter the CSV file on to an Advance spreadsheet and follow simple instructions to produce a print-out of the data processed into a line graph. At this point, the pupils can refer back to the graph produced from the Trangia test and compare the performances of each, thus giving them valuable testing and evaluative information to comment upon.

■ Cross-curricular links

After the first trial of this system with a pilot class, the mathematics and science departments were invited to see the whole project and to witness a test. They were asked to comment on how we could ensure continuity of delivery across the specialisms and on how the duplication of skills could be pointed out across the areas to help pupils to make links across the subject areas. There was also some advantage in reinforcing similar concepts in other areas.

The outcome of this meeting has been positive so far, though next year's delivery will provide the real evidence of whether the cross-fertilisation of ideas has been put into practice. The maths department was able to give an insight into the ability of a Year 7 pupil with regard to graphs and scales and being able to read off data from a line graph. The department has now proposed teaching graphing as early in the academic year as possible, to give pupils a greater understanding of what they are about to tackle. The Stove print-out should reinforce that teaching, putting it into a meaningful context in a different area.

The science department pointed out that greater emphasis could be made of the fire triangle (fuel: heat: oxygen) when teaching the design principles of the stove. The testing procedure was deemed to be sound and in accordance with science principles and would again help to reinforce existing practice.

■ The final reward

On completion of the project, the pupils bring in a hot beverage to which they can add hot water which has been boiled on their stove. To the pupils this is seen as a real treat and one which encourages them to complete all of their work. However, the smell of coffee, hot chocolate and Pot Noodles mixed with the smell of 20 meths burners leaves a lot to be desired for the staff. Nevertheless, the pupils continue to enjoy the experience and on questioning they prove that they have absorbed a great deal of knowledge and awareness. They thoroughly enjoyed the IT input, coping very well with the information given them to guide them through this new field.

Their responses did signal a missed opportunity to push home the link that an interface makes between the computer and sensor, but we hope that next year this will be corrected with an appropriate worksheet to help reinforce the classroom teaching.

In Year 8 a similar approach has been adopted, reinforcing the work done in Year 7. Each pupil designs and makes a propeller-driven buggy with the emphasis put on aerodynamics, friction reduction and steering. The Smart Box is used to analyse the performance of each buggy, recording the results from a time trial track.

Although with both projects we have provided INSET for all of the six staff concerned, problems had obviously occurred. These have tended to disappear as staff have become more familiar with the procedures and equipment and the knowledge that very little input is needed from them as both programs tend to run themselves.

The Engineering Council has expressed a keen interest in the format of the stove project and is to publish a complete guide to running it (through TEP), including a pupils' booklet, list of materials and program listing.