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Reviews

Welcome to the Summer 2002 issue of Electronics Education which features a variety of informative and thought provoking articles. Remember, if your class is undertaking any interesting projects or you simply have a cost or time saving tip to share with other teachers, we want to hear from you!

Please send all contributions to The Editor, Electronics Education, IEE, Michael Faraday House, Stevenage, Herts SG1 2AY or email cfaulkner@iee.org.uk
**Bridge the Gap**

The Construction Industry Training Board has launched a new free CD ROM linking Design & Technology, Science and Mathematics. Called 'Bridge the Gap' the CD ROM, designed for pupils at KS3 includes five weeks of teacher’s lesson plans, notes and ideas. At the end of five weeks individuals are encouraged to communicate, apply critical thinking and management skills by demonstrating that they can work together in small teams to provide a successful design solution for a bridge in an unusual context. The CD was specifically created by teachers and construction engineers to help pupils gain a better understanding of how their skills will be applied to a real job when they are working in industry.

For more information and details on how to receive your free copy of 'Bridge the Gap' contact the local Education Team Administrator at your local CITB Area Office:
- Greater London 01732 467300,
- Southern Counties 023 8062 0505,
- South West: 01392 444900,
- East 01582 727462,
- Midlands 01509 610266,
- North West 01744 616004,
- Yorkshire & Humber 0113 252 1966,
- North East & Cumbria 01355 516 3900,
- Scotland 0141 810 3044,
- Wales 01656 655226

**The Royal Navy steams ahead with Maths and Engineering in Action**

www.rn-maths.co.uk

The Royal Navy has launched a new website for A level maths students. It covers significant areas of the AS and A2 examination specification and brings maths to life by demonstrating how it is used in a range of true-to-life situations and problems that make the most of the potential of the internet.

By placing students in the 'hot seat' and giving them situations to resolve that they would face daily as an Engineering Officer in the Royal Navy, www.rn-maths.co.uk demonstrates how maths can be a central part of the working lives that many students aspire to. Students can complete complex navigational tasks and see some of the maths used behind defence and attack systems used on board Royal Navy ships.

Maths and Engineering in Action comprises four self-contained modules that focus on projectile motion, vectors, calculus and probability. Students are given a scenario and can work independently to calculate the solutions, or are taken step-by-step through the workings required. On-screen graphics and a calculator provide support and each module takes 2-3 hours of teaching time to complete.

**Annual Young Navigators’ Competition**

The Royal Institute of Navigation will be awarding fantastic prizes in a free competition aimed at people between the ages of 9 and 23.

The competition will be asking for an essay on projects with a title chosen from a wide range of categories ranging from animals, pedestrians in the wilderness to space and ballooning to name but a few. The essay can even be written as part of GCSE project or Duke of Edinburgh Award’s log and group projects are accepted. However all the entries must show that there is a clear understanding of what ‘navigation’ means. For more information find your way to www.rin.org.uk
Crocodile Clips software is a favourite with D&T teachers

Crocodile Clips software has been named as one of the most effective ICT resources for Design and Technology (D&T) teaching in the UK. In a nationwide survey of classroom teachers, the Fischer Family Trust Report found that Crocodile Clips software is considered to have a substantial impact on pupil’s learning.

Crocodile Clips software is used by 40 per cent of the D&T teachers who responded to the survey. Only Microsoft Word is used more widely in Design and Technology classrooms. Crocodile Clips software also received one of the highest ratings for the extent of its impact. Over 60 per cent of the D&T teachers who nominated Crocodile Clips stated that the impact of the software is either substantial or significant. Of the 32 top ICT resources for secondary D&T, Crocodile Clips was rated second most valuable, after interactive whiteboards.

Crocodile Clips has been writing and publishing software for use in Design and Technology since 1994. The company has also developed software for Physics, Chemistry and Mathematics.

For more information visit www.crocodile-clips.com

Young Foresight .. shaping things to come

Young Foresight is a revolutionary project aimed at giving students direct experience in all the skills needed to create a successful product or service: from conceptualisation, to design, to adaptability in the market place. It encourages students to anticipate future trends and consumer behaviour and design products that will perform well in a world that hasn't yet arrived. The project aims to bring design and technology alive in the classroom by introducing local industry to its future workforce and helping teachers meet the standards set by the new curriculum. Across the UK companies will be working alongside schools to brainstorm about the future and develop real products for tomorrow’s world.

Through Young Foresight pupils in Year 9 will have the opportunity to design products and services for the future. This task will be challenging yet not daunting as teachers can structure the work successfully using the Young Foresight resources to prepare students for the increased demands of GCSE courses.

To find out more about the way the scheme could work in your school click to visit www.youngforesight.org

Make a leap of imagination with 2020 design a future!

www.channel4.com/2020

Going live! 2020 DESIGN A FUTURE is a brand new challenge website for 10–19 year-old designers, hosted by 4Learning as part of Science Year.

2020 DESIGN A FUTURE is all about forward thinking – and original design – with 24 challenges that address social and technological issues likely to be of importance in the year 2020.

Young people who are passionate about design, and want to create for tomorrow today can visit the 2020 DESIGN A FUTURE website at www.channel4.com/2020 and explore a 2020 world described in 12 different scenarios. There are two challenges for each zone – one open, one specific – giving two levels of creative freedom... and they can present their design solutions – from clothing to electronic systems – in whatever media they like!

WIN £500? BE ON TV? The competition offers prizes for first and second place – £500 and £300 respectively – and 12 runners-up prizes of £100 each. Judging will take place in the Autumn, and winners will be showcased in a special 4Learning programme about the competition!

Competition closes 31 August 2002. Entry is open to individuals and teams.
A plea to the exam boards—dump the BC108!

by Clive Seager

It's now four years since I first expressed my views about the BC108 transistor in Electronics Education (Summer 1998 edition) and amazingly it is still the article that most teachers I meet on INSET courses thank me for! A recent visit to the warehouse at Rapid Electronics (one of the UK's major component suppliers to schools and industry), where I saw huge stocks of this device, prompted me to re-address this issue.

Table 1 shows the annual wastage by schools on this single component – almost £25k with Rapid alone. Considering the fact that not all schools purchase from Rapid, it is astounding at how much money is wasted on this single device each year. It is also interesting to note that in the same period, Rapid didn’t sell a single device to an industrial customer! Quite simply the UK education system could afford an extra electronics teacher if they moved away from this terribly dated device!

Why move away from this device?
1. Plastic cased transistors (e.g. the BC548B) are less than quarter the cost of metal can transistors.
2. The BC108 uses a metal can ‘top hat’ style case that is no longer used in industry because it’s hard to use in pick and place machines and is expensive to produce. Therefore no-one in industry would ever consider using it.
3. In the classroom the metal can is harder to solder successfully, and it is harder for students to identify which leg is which.
4. The plastic cased devices can still be used in any classroom PCB project designed for the BC108, and so no project re-designs are needed.

So why do schools still use it?
There are three main reasons why many schools still use this device:
1. Lack of information – many teachers are unaware there is an alternative.
2. Exam questions are still being set that ask students to identify/use the metal

Table 1

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>BC108 Transistor Sales to Education:</td>
<td>£350,000 per year</td>
</tr>
<tr>
<td>BC108 Transistor Sales to Industry:</td>
<td>£0 per year</td>
</tr>
<tr>
<td>Cost of 350,000 BC108 Transistors:</td>
<td>£33,250.00</td>
</tr>
<tr>
<td>Cost of 350,000 BC548B Transistors:</td>
<td>£9,100.00</td>
</tr>
<tr>
<td>Annual wastage by UK Schools:</td>
<td>£ 24,150.00</td>
</tr>
</tbody>
</table>

(Figures based upon Rapid Electronics annual sales and an average school purchase at the 100+ price break). (Please note that Rapid charge the same mark-up on each part, it is the trade cost price that varies).
can transistor, and so teachers who already use the plastic devices still have to make sure that students are aware of the metal can device. This causes great frustration with the teachers I have met who just want to get on with using the plastic cased devices.

3. I have been told by certain authorities that ‘teachers are familiar with the BC108 device and wouldn’t like the change’. Personally I find this a bit patronising for the teachers – any teacher who has to update their course for a new syllabus/specification every couple of years could certainly handle using a new shape of transistor! My experience as I move around the country is that every teacher I talk to about this subject would much rather save money, and are not in the slightest bit worried about having to use a different shaped device!

What is the way forward?
The only way forward in this area is for the exam boards to specify that, in the future, they will only make reference to plastic cased transistors. I don’t mean a particular device, just that candidates will be expected to know about the function of a transistor and recognise a transistor from the picture of a plastic cased device.

The UK education system cannot afford to throw money away like this, and it is actually such a simple thing to change – but the exam boards are the only people who are in the position to do this.

I’m not suggesting it should happen overnight, but as far as I’m aware no exam board states that students must use metal canned transistors, and so no formal specification changes are required. I believe a special instruction to schools would solve the problem that already exists (where some schools already use the plastic cased devices and some schools are still using the metal canned devices).

I enclose a sample ‘Special Information’ sheet in Table 2 that the exam boards are more than welcome to use, but please remember you must still teach to your exam boards specification until they produce a similar document!

Table 2
Please note this is a sample only – you must wait to see what your exam board does!
AQA GCSE Design & Technology: Electronic Products Specification 2003

2003 will see the first examination of the new AQA GCSE Design & Technology: Electronics Products specification (syllabus). The specification evolved from the current AQA syllabus, taking into account new QCA and Curriculum 2000 expectations, and has many features in common with that popular examination. There are some important changes, however, and this article is intended to give an overview of some of these modifications.

Much of today’s electronics industry uses the basic building blocks included in this specification to develop the electronic products we commonly use in everyday life. For many years electronics has been taught in schools through the systems approach which is based on the idea that complex functionality is achieved by connecting a variety of relatively simple functions together. In the AQA syllabuses, these simple functions are known as Basic Building Blocks. Much of today’s electronics industry uses the basic building blocks included in this specification to develop the electronic products we commonly use in everyday life. It is the premise of the present, and future, specifications that GCSE students should move forward from this stage of their education with a clear understanding of the Basic Building Blocks which combine to form the products with which they will work and spend their leisure in the future. These building blocks include potential dividers, monostable timers, astable circuits, latching circuits, comparator circuits, counting circuits, voltage amplifiers and simple logic and are essentially a continuation of those included in the current syllabus.

No change of philosophy

Making way for PICs

Some elements of the current syllabus have been removed from the materials and components section of the 2003 specifications to make way for the inclusion of PIC technology. Candidates will no longer be required to learn about S R flip-flops or D Type flip-flops. Much of the knowledge associated with transistors, basic components, electronic switches and counting circuits has been reduced and, in order to allow teachers to focus their activities, specific ICs (e.g. 555, CMOS 4017) have been identified in the specification.

Putting PICs in their place

Microcontroller technology (eg. PICs) technology has been slowly revolutionising the electronics industry for many years and, thanks to the work of education specialists who have developed simplified programming systems this technology is widely available to schools and has been included in the 2003 specifications. There are teachers out there who say, ‘We can do it all with PICs so why do we have to bother with all the other
stuff? Industry doesn’t.’ In fact 555 circuitry, latches, comparators etc. are used extensively in a vast variety of auto and domestic electronics. However, the main point is that candidates at GCSE level need to gain a foundation in systems electronics which will allow them to use developing technologies more effectively if they take the subject into further or higher education and to give them a basic electronics literacy needed to operate effectively in the modern world.

The structure of the specification
The content of the specification is divided into four sections

- Designing and Making Skills (common to all D&T Specifications)
- Materials and Components
- Design and Market Influences
- Processes and Manufacture

The materials and component section defines the unique nature of the specification and the content contained in the other sections should be interpreted in the light of the content in the materials and component section.

For example the first paragraph of the making skills ‘to match materials and components with tools, equipment and processes to produce quality products;’ seems too broad to be teachable until related to the materials, processes and construction techniques specified in section 10.

Similarly the designing skills requirement to use CAD is defined and restricted to the use of CAD specified in section 10.15.

The 40 hour project
The purpose of QCA in stipulating that all examination boards require the major project to be completed in 40 hours is clearly to reduce the workload on candidates during Year 11. It would be quite wrong to suggest that this requirement will have little real effect in the workshop. On the contrary, The long established tradition that higher ability candidates spend inordinate amounts of time designing and making their major project has to change. It is simply not fair that candidates feel that they need to spend more time on design and technology to achieve a high grade than they do in other subjects. There is no suggestion that a 40 hour project will give rise to work of a lower standard but it is expected that candidates will need to be more efficient in their use of time. For instance, it is now even more important that research and analysis is confined to that which is relevant to developing the candidate’s product. It is worth noting that Designing Skills and Making Skills are assessed in the ratio 33:67 in project work.

A typical mid-ability 40 hour project could culminate in a product which times a specified event. This may consist of a design folder which shows research into alternative methods of triggering the device, alternative outputs, alternative methods of producing the monostable function and alternative case designs. The folder should demonstrate the candidate’s ability to draw circuit diagrams, use CAD to produce track layout and plan for the production of a quality product. The product is likely to be simple in design and made of styrene, wood, acrylic or a combination and will demonstrate good fabrication or vacuum forming skills. The PCB will have been made, populated and soldered by the student and should demonstrate a high level of skill. LEDs etc will be insulated and external components fitted accurately.

A typical higher grade project will demonstrate enhanced skills and show a higher level of demand by including more than one process block in the circuit design. For example the process unit might be a time delay followed by a latching circuit as part of an alarm. This double function process unit could be achieved in a number of ways including separate IC circuits, a single IC performing the two functions (e.g. a Quad 2-input NAND gate IC acting as a latch and monostable) or by using a PIC.
programmed to give both time delay and latch the output. Because of the time restriction it is envisaged that few students will seek to go beyond two process blocks.

**CAD and CAM**

All new Design & Technology specifications have an increased emphasis on the use of ICT to aid designing and making. CAD (Computer Aided Design) and CAM (Computer Aided Manufacture) are likely to be the main sources of this evidence and it is important that their use is appropriate to the work and helps the candidate to achieve a higher standard of development and communication of their ideas and an improved quality product. Evidence of CAD/CAM use should not merely be included so that we can ‘tick the box’ which says its use is expected in DT! As with any designing and making evidence, it should be relevant to the candidate's solution of their design activity.

Some general points to consider:

- CAD evidence in project work should not be limited to Computer Aided Drawing. It might include:
  - the use of drawing software to help candidates to develop and communicate their ideas. (Its use to illustrate part of the candidate’s project may be the most appropriate use given the time constraints of the work. It is more likely to be of use in communication of the final solution rather than in early generation of ideas)
  - modelling ideas (e.g. using modelling software such as ProDESKTOP to investigate form and finish for a product, simulation software such as Crocodile Clips to mimic possible solutions)
  - researching and analysing information, such as availability and cost of materials and components, from the Internet and CD-Rom based databases etc
  - using a digital camera to help illustrate the design folder e.g. the design situation, prototypes and stages of production and the evaluation of the product

- an awareness of the role of CAD in the industrial development of similar products.

Similarly, CAM evidence should not be limited to Computer Aided Machining. Whilst this part of CAM is very important in industry, its use may not be relevant to the product under development. Even where it is relevant, and the equipment is available, the machining time is likely to make its use for all of the product inappropriate. Use to create part of the candidate’s product, such as the circuit board or surface detail for the lid, coupled with description of how it might be used for the rest, will be the best approach in many cases.

**A teachable short course at last**

The short course specification has been dramatically reduced in the content of the materials and component section. While the standard of design work and the quality of making is the same for the short course as for the full, the level of demand expected for higher grades is limited to only one process block.

The requirement for knowledge and understanding of diodes, relays, power supplies, transistors (other than as transducer drivers), operational amplifiers, logic, electronic switches, Bistable and counters has been taken out of the short course altogether and has been reduced in respect of materials, components, mechanical switches, resistors, potential dividers and interface devices.

**Advice and help whenever you want it**

The senior examining team and the AQA staff have always sought to provide you with the help and advice you need but from 2003 they are making such help and advice much easier to obtain. Each centre will be associated with a ‘Coursework Adviser’ who will be able to help with many aspects of project selection, management and application. Help will just be a phone call away!

Richard Calvert (Principal Examiner AQA D&T: Electronic Products)

Dave Mawson (Assistant Chair of Examiners responsible for AQA D&T: Electronic Products and D & T: Systems and Control Technology)
Tread Safe
‘A Stair Aid for the Blind’

by Tom Allen, Chris Harrison, Richard Strange and David Gouldby

The four members of the team, all aged 16, from Nottingham High School have been working on the project for a couple of hours every week after school on a Friday for the past fifteen months, aiming to enter the project in the Young Engineers and the Young Electronic Designer Awards.

We decided that we wanted to design something that would benefit a large number of people. As one member of the group has no sight in his left eye, we decided that it would therefore be appropriate to help the blind. We discussed areas of danger which visually impaired people have to encounter in their daily lives. We believed that a system, which would tell them that they are approaching the stairs and to inform them of the number of steps in the flight, would eliminate any surprises that could lead to an accident. Originally the system was designed for use in a home environment, and we therefore designed and built a system which could only be used by one user. The system can only be used by a single user because the four message loops system works on the principle that if you go up stairs you must come down again, and if another user triggers the system the messages would become out of sync.

There is an infrared beam at the top and bottom of the stairs, the outputs of both receivers are fed into an EXOR gate, so when one of the
beams is broken a logic 1 is produced. The user wears a radio transmitter, so only blind people with transmitters can activate the system, and the voice does not distract or irritate sighted people. The signals from the EXOR gate and the radio receiver are fed into a NAND gate, which produces a logic 0 when both inputs are high. This low triggers a monostable, which causes a message to be played back by the voicechip and disables the system so that another message cannot be played back until the user is clear of the IR beam. A decade counter counts the message and resets the voicechip after the fourth message has been played back, forming the four-message loop, explained in the diagram.

We tried several infrared and radio circuits, because it was important that both the infrared and the radio gave out strong reliable signals, whilst trying to keep the cost of the project to a minimum. Tom designed the voicechip reset system and control circuits (the EXOR and NAND gate circuits) from scratch. However the project still managed to provide us with endless problems, all of which we managed to solve and eliminate, with very little, if any, help from our teacher.

Our first version of the system did not know the location of the user, and relied on a four-message loop. This also meant that the system could only be used by one user, and could only really be used at home - an environment that a blind person would probably be very familiar with and the system would therefore be unnecessary.

We later realised that a multiple-user system that could be set up in any unfamiliar environment would be more beneficial to large numbers of blind people all over the country. We have designed a system with two voice chips (one for the top and one for the bottom of the stairs). This system can be used by infinite users, and could therefore be installed in an unfamiliar environment, such as a shop or a day-care centre. Every user would have a radio transmitter, and all the systems could have the same radio code, so users would be able to use the system in more than one place. The shop/public building would buy the rest of the system for the stairs. The radio transmitters would cost under £5 pounds each and the rest of the system under £40.

We discovered that in Nottingham alone there are 19,000 visually impaired people registered with the Nottinghamshire Royal Society for the Blind (NRSB). Our research also found that the majority of these people were unable to get out and about on their own and therefore had limited independence, because they do not have the confidence due to hazards that they cannot see.
For this reason the system has a huge market potential. Not only would the system attract a vast number of new customers to those who decide to install the system on their premises, but most importantly it would give the Blind confidence in unfamiliar surroundings.

Also, because the messages are recorded simply by plugging a microphone into the voice chip, the system could be used to warn the visually impaired of hazards, other than the stairs. It could even be used to give directions to the toilets or fire exits, or even to welcome them to an attraction or a shop. And because all the systems can be made to receive the same coded radio signal, every blind person with a transmitter can trigger every system in a town, city, or even the country.

In June 2001 six visually impaired members of the NRSB visited the school to test the system. After we had explained how the system works, they tested it out and gave us their honest opinions. All the guests were thoroughly impressed with the stair aid and agreed that a multiple user system would be very useful to them in unfamiliar environments, such as shops. The NRSB also provided us with pairs of goggles to demonstrate different degrees of blindness, so we were able to test the system ourselves from the point of view of a blind person, this made us realise the potential of the system that we had designed. The six members of the NRSB were very grateful that we had decided to help them, as there are currently no similar products on the market.

The team reached the regional finals of both the Young Engineers and the Young Electronic Designer Awards. After the regional final of the YEDA at...
Northampton we gained a place at the national finals at the Science Museum in London. It was an amazing experience, which we shall never forget. We were delighted to be awarded 3rd prize in the intermediate category, especially due to the fact that part of the project did not survive the journey to London and we were unable to overcome the problem.

A message will only be played back by the system when the infrared beam is broken and the radio signal is being received at the main unit. The range of radio signal being transmitted by the unit attacked to the user is greater than the distance from the IR beam and the main unit, so the radio signal will definitely be present when the IR beam is broken.

The messages are recorded manually onto the voice chip. Therefore the content of each message can be recorded as desired by the user. For demonstration purposes we have pre-recorded the message – see left.

The Voice chip will reset after the fourth message forming a loop. The order in which the messages are played back is shown in Fig. 3.

For information on YEDA visit www.yeda.org.uk and for Young Engineers visit www.youngeng.org/
Bridging the digital divide

Like it or not mobile phones are an integral part of modern living. Simon Maddison explains how his company MobileInclusion Ltd has developed a positive application for this technology to benefit the school-parent community.

Everyone knows that mobile phones are used for voice calls, and their use for sending text messages has exploded in the last two-three years. However applications which are data orientated, such as information retrieval and database interaction are in their infancy.

Three key enablers are needed for this to really take off successfully:

- Networks
- Devices
- Applications

Although mobile data access has been available for some time, in the form of dial up, data enabled networks are now being deployed by all operators and becoming widely available. In the UK this is popularly know as the 2.5G network, which runs on the existing GSM mobile network infrastructure, using GPRS standards. This enables data access as and when needed, without having to make a dial up connection.

The first data enabled phones were the WAP phones, with a simple web browser incorporated within the device. Many new phones are now WAP enabled, and the first 2.5G phones are also appearing on the market. There are likely to be many exciting new devices with extended functionality being released during 2002, with and without 2.5G capability.

As for applications, the main focus in the industry has been on the needs of the technically savvy executive, to enable him/her to be able to access email and other corporate data wherever s/he is, and at any time.

We have a different agenda. Our vision at MaviCom is to create applications of real and practical value, and to do this with stand-alone mobile devices. One of our areas of application is on products of social relevance and value.

The first of these applications is ‘Inclusion’, a productivity tool aimed at schoolteachers, with additional benefits for building the school-parent community.

What it does

‘Inclusion’ enables a teacher to take a class register, using a WAP enabled mobile phone. Using the menus, the teacher selects the class for the register, and then notes against missing pupils the reason for absence.

When complete, the registration data is updated in a central database. A monitoring system then checks for unauthorised absences, and depending on rules configured for each school, messages will be sent to the parent or carer of the absent child. In particular it will send a short text message (SMS) to the parent’s mobile phone.

Other functionality allows the teacher to send a text message to all the parents of children in a specific class, by simply entering the message and selecting the specific class. This is a powerful tool for notifying parents of upcoming events such as school trips or open days, or for reminding about tests and examinations.
The advantages that 'Inclusion' offers over existing solutions include:

- Instant update of the school registration database, fast and immediate
- Teacher only requires a simple commodity device to perform registration; no need for expensive technology to be installed throughout the school
- Instant communication with parents and other concerned parties
- Creation of an informed and interactive community formed of class parents, teacher and school

**How it works**

'Inclusion' works around a web-based application server, which runs the central application and manages a secure database for the pupil information. This is accessed in two ways. Firstly the school administrator accesses this via the Internet, using a standard web browser.

Using this the school data is set up and configured, including the school timetable, class pupil lists, and parental contact information. Interfaces allow efficient up and downloading of data, and inter-working with existing school management and registration systems.

Teacher information is also entered into the system, and the teacher's phones can be configured for access 'over the air' by sending an SMS message. This SMS message is detected by the phone, and configures a shortcut and other access information, which enables the user to access the 'Inclusion' server.

The teacher accesses the system by
means of a standard WAP phone. The shortcut to reach the application server (like a URL in a web browser) can either be manually entered, or automatically programmed by means of a short message sent out to the phone from the server. Manual editing can be time consuming and error prone, particularly with the limited capabilities of a mobile phone, so the configuration using an SMS message is far preferable.

When the teacher wants to use the system, he/she selects from a simple menu. The amount of information that can be effectively displayed is limited by the device, so the system keeps data simple and to a minimum. Since devices have different characteristics, it is both possible and necessary to format the information according to the type of device. The server detects this, when the initial access is made. Since the data produced by the application server is in XML, content adaption is achieved by applying an XSL style sheet specific for each type of device.

**Practical trials**

A pilot version of ‘Inclusion’ was run successfully during the summer of 2001. The feedback from these trials has been incorporated into the product development programme, through the second half of 2001. We are now in the process of commercialising the product, in conjunction with mmO₂, the mobile spin out from BT. Commercial launch is expected in the first half of 2002.

**Further developments**

A lot of very exciting developments have started to take place in the mobile market, during the latter half of 2001. Many new data enabled devices are poised to appear, addressing both the consumer and the business user.

For us, the most exciting devices are the mobile data enabled PDA’s (Personal Digital Assistants). These include devices with Microsoft Pocket PC and Palm operating systems. Although initial prices are quite high, it is expected that they will drop quickly, so as to become...
The capabilities of these devices are far higher than a standard WAP phone, both in terms of processing power, storage and display. Our recent development work has focussed on these, with the aim of making the application easier and quicker to use. Rather than using WAP, these versions require a small application on the mobile PDA, which exploits the direct data connection from the device to the server. The downside of this, compared with the simple WAP application, is the need for a client application to be loaded onto the PDA. However we are also providing network configuration tools to address this issue, and the benefits in terms of usability are more than worth it.

Other applications
One of our initial concerns about ‘Inclusion’ was the penetration of mobile phones amongst parents. This was particularly an issue in poorer areas where truancy is more likely to be a problem. However the feedback that we received from the local education authorities was that this was not likely to be a significant problem. Mobile penetration is very high amongst all demographic groups.

Moreover, as most teachers are acutely aware, mobile phone penetration is high amongst pupils. This leads to other possible extensions of ‘Inclusion’, in terms of the whereabouts of truant children, using the location facilities that networks are beginning to provide.

Interestingly, one of the best insights of the trial as to ‘Inclusion’s’ features was that the messaging facility was the most valuable part of the service. The potential for building more effective communications between teacher and parent were clearly recognised. Since many children are also users of mobile phones, another possible extension of ‘Inclusion’ would be to provide an easy way for children as well as parents to receive information about homework assignments and upcoming tests.
Surround sound

by Michael Brimicombe

Dear Diary ....My Dad's always going on about how much electronics has changed. Normally he is quite tedious about it. Like last week when I was programming a PIC for homework and he told me all about the Sinclair Spectrum computer he used a quarter of a century ago - apparently it had the same amount of RAM as my PIC and ran at about a quarter the speed. Anyway, yesterday was different. He told me about something which I'm going to chase up for my project.

Bad contact
My Mum got rebellious yesterday. She had a big row with my Dad. It was about the sound system in our living room. A lot of it is quite old, especially the amplifier which my Dad built from a kit when he was my age. Every so often, the left-hand channel packs in because the contacts on one of the circuit boards get tarnished. Dad solves the problem by pulling out the board and pushing it back in again. However, Dad's been away all week on a business trip and the sound system packed in just after he left. Mum wouldn't let me fiddle with the system (she's frightened that I'll electrocute myself), so we just had to do without until he came home. Mum and Dad are going to buy a new system at the weekend, and the old system is going to be donated to school!

Making a difference
As he was packing up the old sound system, Dad told me about the part of it which died years ago. He'd built an amplifier which fed the difference between the left and right signals to a third loudspeaker. I've drawn what he can remember of the circuit in Fig. 1. Someone had discovered that recording engineers usually didn't pay any attention to the phase difference between the left and right signals, mainly because it didn't make any difference if you were listening in ordinary stereo. However, if you fed the difference between the left and right signals to a third loudspeaker behind the listener, this phase difference would often give the listener the impression of being in the middle of the band instead of in front of it.

So that's what I'm going to do for my project. Build a surround-sound circuit for my own small sound system, the one in my room at home.

Specification
My block diagram is shown in Fig. 2. Mr. Jones is very unhappy with it — he says that it's too simple and that I won't be able to earn many marks. He also doesn't like the idea of my testing the system at home with my sound system. He won't let me borrow school's power supplies and oscilloscopes to take home, and he wouldn't be sure how much help my Dad would give me. In the end, I complained to Dr. Smith. He said he was happy for me to keep my sound system locked in his office overnight. He also
persuaded Mr. Jones that he would be able to think of an extension to my project if indeed it turned out to be too simple. So I can go ahead.

**The first stage**

Fig. 3 shows the first stage of my system. It’s a standard difference amplifier, based on an op-amp rather than the transistors that my Dad had to use. (Apparently his circuit was built around something called a long-tailed pair.) I’ve put it together on my breadboard today and done a bit of testing. I set up a pair of potentiometers to set up separate signals for the inputs and connected voltmeters to the inputs and outputs. Apart from when the op-amp output saturated at about +13 V or -14 V, the reading on the output voltmeter was always equal to the reading on the A meter subtracted from the reading on the B meter (Fig. 4). I also found that if the inputs got below -14 V, the output went mad and shot up to +13 V. Mrs. Brown says that it’s nothing to worry about, all CMOS op-amps do it.

**Second stage**

Fig. 5 shows the circuit that I’ve been working on today. It’s the volume control for my third loudspeaker. I’ll need to be able to boost my signal as well as cut it. The circuit has two parts. The first part uses a potentiometer to allow a gain of anything between +1 and 0, depending on the position of the knob. The second part provides a fixed gain of -4.7. So the overall gain can be set to anything between -4.7 and 0. To test it, I just added a voltmeter to the output and connected the input to my difference amplifier (Fig. 6). Provided that I avoided saturation of the op-amps, it seemed to work OK, for both positive and negative voltages.

**Bad alternatives**

Mr. Jones has been telling us that we get extra marks if we actively consider alternative designs for our circuits. So I’m going to waste a bit of time today in testing two alternatives for my second stage. I already know why they aren’t as good as my previous design. The first one is shown in Fig. 7. It boosts the signal by a fixed -4.7 before cutting it with the potentiometer. Its overall behaviour is still the same as my circuit
of Fig. 5, but it can’t cope with anything larger than \(13/4.7 = 2.8\) V at the input without saturating. (My previous circuit can cope with the full range of voltages at the input, because I can cut the signal before it gets boosted.) The second bad alternative is shown in Fig. 8. It uses a non-inverting amplifier, so the overall gain of the system can be anywhere between +4.3 and 0. The positive gain means that the system might get unstable and start to oscillate (well, that’s what Mr. Jones taught us!)

**Still stable**

Testing the two bad alternatives took longer than I expected. The first one was easy, but I had a lot of difficulty in getting the second one to oscillate. At first, I thought it was because I was using a voltmeter, and therefore wasn’t going to be able to show me any AC signals. So I used an oscilloscope instead, but the trace was flat—no wobble at all. It wasn’t until I replaced the 3.3 k\(\Omega\) resistor with a 330 k\(\Omega\) resistor that the system started to oscillate—so it obviously doesn’t become unstable unless the gain gets big enough. Anyway, I’ll stick to my original design.

**Unexpected signals**

I had a bad time today. I brought my sound system to school (without the speakers—there are plenty of spares sitting around the laboratory) with the idea of testing what I had built so far. Mr. Jones is worried that if I bust the sound system on school premises he’ll have to pay for it to be mended, so he took charge. We started off by putting on a CD and connecting the oscilloscope to each of the four terminals in turn. Two of them had no signal at all, clearly connected to 0 V (see Fig. 9). But the other two terminals didn’t have the expected signal on them. On the screen, each signal seemed to be a blur between +12 V and -12 V (Fig. 10). No amount of messing about with the trigger controls or the timebase made any difference—it was just a blur!

**Dr. Smith to the rescue**

In the end Mr. Jones went off to fetch Dr. Smith. I reckon he was worried that he’d managed to break my sound system. Dr. Smith was in a mood when he appeared with Mr. Jones, but smiled
as soon as he saw the trace on the oscilloscope. He stopped the CD playing, and the screen froze immediately into a clean square wave pattern (Fig. 11). The output was spending 20µs at +12 V and 20µs at -12 V, alternating between the two. As soon as the CD was put on again, the trace blurred as before. Fig. 12 is a copy of the sketch that Dr. Smith used to explain to me what was going on. (Mr. Jones took away the original at the end of the lesson.)

**Not push-pull**

According to Dr. Smith, my sound system uses pulse-width modulation to run my speakers. Instead of feeding an audio AC signal to my speaker, the system feeds out a series of 20µs pulse at a fixed +24 V, with the spacing of the pulses fixed by the audio signal. So when the audio voltage is positive, the pulses are close together. This gives an average positive voltage across the speaker. A negative audio voltage has the pulses further apart. Averaged over a few pulses, this gives a negative voltage across the speaker. And, of course, when the pulses are 20µs apart, the average voltage across the speaker is zero. So the output stage of my sound system is not a push-pull transistor setup like the one shown in Fig. 13. Instead, there must be a different arrangement of transistors (Fig. 14), where the transistors take it in turn to be on, forcing the output to be at one supply voltage or the other, but never anything in between. Because the transistors are always saturated, they don’t get hot (they have the same voltage at emitter and collector) and all of the power from the supply rails always gets delivered to the speaker. In a normal push-pull system, the power is shared more or less equally between the transistors and the speaker. As Dr. Smith pointed out, since my system is more efficient it can get away with a smaller power supply, saving both money and weight. It also doesn’t need big heatsinks on the transistors, also saving on bulk and cost.

**New diagram**

The way forward is now clear. I’ve drawn up a block diagram for Mr. Jones (Fig. 15). Dr. Smith tells me that the filters will recover the left- and right-
hand audio signals from the outputs of my sound system. Then comes the difference amplifier and volume control. The next three blocks convert this new audio signal into a pulse-width modulation signal for the third loudspeaker. The last of the three is a monostable, putting out a 20µs pulse each time that its triggered. The other two blocks need to obey this formula, worked out by Dr. Smith as he explained how my sound system worked:

\[ f = \frac{V + 12}{2} \times 25 \]

\( V \) is the audio signal coming out of my volume control and \( f \) is the frequency (in kHz) which needs to go into the monostable. So the middle block of the three is a voltage-to-frequency converter. As yet, I have no idea how to make this, but I’m sure there will be one in *Electronics Expounded*.

**Cutting the treble**

I spent today designing, building and testing the treble cut filter shown in Fig. 16. According to the formula in *Electronics Expounded*, it should filter out signals above 16 kHz. Since I can only hear sounds that are below 16 kHz, that should be OK. I tested it by looking at the output with the oscilloscope with the input connected to one of my speaker connections. Fig. 17 is an example of a typical trace; a high frequency AC signal wobbling up and down with a lower frequency AC signal. Mr. Jones says that I shouldn’t worry about the high frequency AC signal as I won’t be able to hear it (it should be 25 kHz or higher, according to Dr. Smith).

**Two-dimensional sound**

Today was spent testing the signal coming out of my difference amplifier. The high frequency blur is still there, but it definitely wobbles up and down with an audio signal. I experimented with lots of different capacitors in the treble cut filters, but in the end I decided to stick with the values I’d originally chosen. Bigger capacitors (10 nF and 100 nF) got rid of the blur, but gave break frequencies so low that most of the audio signal would be lost as well. Once I had given up on cleaning the signal any more, I fed it through my
volume control to my Dad’s old amplifier and speaker. When I arranged this speaker so that it pointed towards my sound system (Fig. 17) you could definitely hear the surround-sound effect. Not just me, the rest of the class could as well. Some CDs were more dramatic than others, but the effect was still there. My Dad was right.

Making pulses
I still don’t know how to do the voltage-to-frequency conversion, so I’m going to deal with the monostable and driver stage today. Fig. 18 shows what I started with – a standard monostable made with a pair of NAND gates. According to my notes, the pulse length is given by the formula \( T = 0.7RC \), so I need 3 kΩ and 10 nF to obtain a pulse length of 20µs. However, when I built it, it wouldn’t work until I eventually changed the values to 1 nF and 30 kΩ—the signal generator at 25 kHz to feed triggering pulses into the system. I have no idea why the circuit wouldn’t work with a 3 kΩ resistor, which is a bit annoying, but it got even more annoying when I added a 741 to convert the 5 V signal to a 26 V one (Fig. 20). Not only could I not get more than a few volts out of the op-amp, the shape of the signal was triangular instead of square.

Slew rate
I spent days trying to sort out my monostable circuit, going round and round in circles and getting more and more fed up. I tried using logic gates instead of an op-amp, but they got too hot when I ran them off supply rails at +15 V and -15 V. In the end, Mrs. Brown caught me sneaking a new 741 out of the drawer and asked what was wrong with the old one. When I confessed, she snatched the op-amp off me, gave me a different one (an 081) and told me to look up ‘slew rate’ in the book. Anyway, her new op-amp did the trick (Fig. 20)—I’ll find out why the old one didn’t work later, as I’m running out of time now.

Driver stage
The signal generator that I’m using to test the pulse system has a frequency modulation option. I can feed in an audio signal and use it to increase and decrease the frequency of the square wave going into my monostable. So

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**Fig. 18** A monostable which should create 20µs pulses, but didn’t

**Fig. 19** Converting the 5 V pulses into 26 V ones

**Fig. 20** Output of the pulse system when an 081 op-amp was used

**Fig. 21** My first attempt at the driver output stage
before I go back to sort out the voltage-to-frequency block, I might as well use this signal generator to sort out my driver stage (Fig. 21). After all, once I put the signal generator back on the shelf, someone else will grab it and I’ll not be able to get it back until project time is over. The transistors which Mrs. Brown issues to us are rated at 1 A, so I’ve used two in parallel. Since my speaker has a resistance of 8 Ω, the maximum current should only be 15 V/8 Ω = 1.8 A, giving 0.9 A in each transistor. However, the transistors got very hot even before I’d connected the speaker, so something was clearly wrong.

Turning off
It took me a while to track down the problem, but I got there before Mrs. Brown became suspicious and banned me from a fresh supply of transistors. Dr. Smith was assuming that only one transistor was ever switched on. When one was on, the other was off. If both were switched on, current could get from the +15 V rail to the –15 V rail without going through the speaker at all. Without any resistance in the way, the current could get big enough to damage the transistors. My pulse output was only getting to within 2 V of the supply rails and I needed to get to less than 0.7 V to turn off the transistors properly. I managed to solve this by sticking diodes between the emitters and the supply rails (Fig. 22).

Push-pull output
Because of all the problems I had with the pulse system and the driver stage, I never got the whole block diagram of Fig. 15 built. With just two days to go, I decided that I didn’t have enough time to sort out the voltage-to-frequency block (I hadn’t even done any research for it in the books), so I opted for a simple push-pull follower instead, with a design taken straight from my notes (Fig. 23). The large 10 Ω resistor was included to keep the current in the transistors well below 1 A, but they still needed to be attached to heat sinks to stop them getting too hot—Mrs. Brown insisted when she saw my notes lying open on the table. Anyway, it was the right decision because I not only ended up with something that worked, but also had gone a long way to sorting out an alternative which would have worked even better.

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**Fig. 22** Adding extra diodes allow the transistors to turn off and not get hot

**Fig. 23** My final system - the push-pull follower was used because I ran out of time before I could sort out the voltage-to-frequency converter
Bits and Bots

The BBC Robot Building Kit

There’s a lot of robomania about at the moment. The Robot Olympics series ‘Technogames’ has recently been on the television and you may be aware of the Real Robots publication where you can build your own robot over the weeks by collecting the parts in each edition. The BBC have added to this interest recently by producing a new robot building kit as part of their ‘Robot World’ experience.

This particular kit has been produced to support the information about robots and animatronics on the BBC’s website: www.bbc.co.uk/robots.

The BBC robots pack comes complete with all the parts needed to build a number of simple robots. Full instructions are given for each type of robot – there are vertical ‘rollerbots’, horizontal ‘rollerbots’, ‘judderbots’ and ideas for other types of robots. Those of you who are familiar with the TEP Bug Kit will recognise that these are more sophisticated variations on this theme.

The BBC Robot Kit is intended as a starter pack to get pupils interested in designing and developing robots and animatronic systems. The basic robot models that you can make with the kit are fairly straightforward and involve simple linear movements, rocking or juddering. There are quite comprehensive building instructions available for each of the five different types of robots together with suggestions for further applications. With all the parts in the kit you can make, at any one time, either three of the simple one-motor robots or one one-motor and one two-motor robot.

With a little bit of imagination you can make your robots ‘come alive’. Rather than just running up and down in a line or juddering about, why not make them switch each other on and off. Using a simple thyristor latch circuit and a couple of magnets and reed switches, you can create your own ‘live’ juddering bots.

Use the circuit in Fig. 3 to control the motor on one of your juddering bots.

When a magnet is brought close to the reed switch ‘A’, the thyristor is switched on and the robot will judder about.

Bringing the magnet close to the reed switch ‘B’ will reset the thyristor and turn the motor off.

If these reed switches and magnets are arranged around the edge of the robot then they could bump into each other and switch each other on and off as they move about see Fig. 4.

Included within the BBC Robots Kit is a TEP IQ micro-controller. This is a simple 3 output sequencer and can be used to turn on lights, buzzers or motors in a pre-determined sequence.

The IQ micro-controller is a small inexpensive programmable controller designed to be used, in some cases, as a consumable ‘component’. It offers a means of embedding ‘intelligence’ into some of the electronics and control products.

With the IQ controller you can:

- Control 3 output devices - LEDs, motors, buzzers, lamps (each up to 800mA)
- Programme simple sequences of events of up to 99 lines
- Vary the timings of the overall program and the individual outputs
- Power output devices directly from the board or from an external power supply

Used in conjunction with the basic kit the IQ micro-controller does add a degree of flexibility and sophistication both to the designs of the 'bots' and to the functions that these can perform.

Your robots can now move forwards, turn corners or follow a pre-programmed path. You could attach 'eyes' to the robot and get it to make noises as it went along.

But you don't have to stop there. Using some of the new PIC chips and the systems available to program them, you can make your simple robots undertake a wide variety of more complex tasks.

You could then add sensors to your robots to make them interact with the environment and watch them really 'come alive' They could evolve in front of your eyes!

The BBC Robot Building Kit is available from the BBC via their website at www.bbc.co.uk/science/robots/techlab. The price of the kit is £25.00 including packaging and postage.

More information about the IQ micro-controller is available from www.tep.org.uk.

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Liquid crystal displays

Students use liquid crystal displays (LCDs) every day of their life. Mobile phones, games consoles, photocopiers, vending machines etc. all use LCDs to display information. Now students building microcontroller systems can incorporate LCDs into their projects.

by Clive Seager

LCDs

LCDs come in two main forms, graphical (where pictures are made from rows of dots (e.g. on most modern mobile phones) and textual (e.g. on vending machines), where just words are used in 2 or 4 rows. Although graphical displays are fairly expensive and complex to use, simple textual displays can now be incorporated into student projects via ‘serial LCD modules’ that are available for around £12 each.

A serial LCD module (Fig. 1) takes a standard 16 character by 2 row liquid crystal display, and adds a microcontroller on a small pcb to the back of the display. This embedded microcontroller then performs all the complex LCD driving routines, so that students can easily output data from systems such as the PICAXE, BASIC Stamp or PIC-Logicator educational PIC systems. A sample BASIC program to display the word ‘hello!’ on the screen then becomes a programming command such as:

serout 7,N2400,("hello!")

It is also possible to output variable values (e.g. temperature readings or scores from games) via commands such as:

serout 7,N2400,("Temperature = ",#temp)

Real Time Clock

One problem often experienced by students within projects is how to build systems that work at precise time intervals. By adding a DS1307 time chip (around £2) to the serial LCD module, students can build systems that display the time on the LCD, and that also activate other events by programming the alarm output. This alarm output can be set at time intervals between 10 second and a year. Therefore, for instance, using this technology a student could easily produce an ‘alarm clock’ that activated a buzzer or motor at precisely 7.00am every day!

The DS1307 time chip is backed up by a 3V lithium coin cell, which ensures the correct time is maintained by the...
module when the main power is removed. The coin cell will maintain the correct time for approximately ten years.

**Snooker scoring device**

This use of a serial LCD module within student projects is best made by example. Imagine you wanted to make a ‘scoring’ system for a game of snooker. This system needs to display the score (between 0 and up to about 150) for two players. In theory this could be achieved by use of seven segment displays, but it seems far more logical to use an LCD type display for this type of application. The full circuit diagram for such a project is shown in Figure 2.

**Microcontroller connections**

The microcontroller inputs and outputs are allocated as follows:

- **Input 0** - This is a simple toggle switch to select between player 1 and player 2.
- **Inputs 1 to 7** - These seven switches are push switches, one used for each colour ball.

  - **Outputs 1 and 2** - These two outputs drive two LEDs placed either side of the player toggle switch, to help highlight which player is currently selected.
  - **Output 6** - This drive a piezo sounder to make ‘beep’ sounds when a switch is pushed.
  - **Output 7** - This drives the serial LCD module. This is a special module that allows the PICAXE chip to drive an LCD via a very simple single wire connection and ‘serout’ commands.

**Program operation**

The program for the microcontroller is shown in Figure 3. The basics of the program operation are:

1. Upon a reset, the players scores (stored in variables b1 and b2) are reset to zero, and the LCD is cleared of messages.
Figure 3 – Program Listing

'PICAXE-28 Program for the Snooker Scorer

init:       let b1 = 0  ' reset player 1 score
let b2 = 0  ' reset player 2 score
serout 7,N2400,(254,1)  ' clear LCD display
pause 30  ' short delay for LCD

' update scores on LCD
main:       serout 7,N2400,(254,128,"Player 1 = ",#b1," ")
serout 7,N2400,(254,192,"Player 2 = ",#b2," ")
let b3 = 0  ' reset colour score to 0

' now loop checking all the colour switches
loop:       if pin7 = 1 then black
if pin6 = 1 then pink
if pin5 = 1 then blue
if pin4 = 1 then brown
if pin3 = 1 then green
if pin2 = 1 then yellow
if pin1 = 1 then red

' also check player switch for correct LED
if pin0 = 1 then light2  ' jump if player 2

light1:  high 1  ' light player 1 LED
low 2  ' player 2 off
goto loop  ' keep looping

light2:  high 2  ' light player 2 LED
low 1  ' player 1 off
goto loop  ' keep looping

' this section adds score to variable b3
' note the multiple entry points
' to give correct value 1 to 7
' e.g. black(7) = 1+1+1+1+1+1+1
black: let b3 = b3 + 1  ' black = 7
pink: let b3 = b3 + 1  ' pink = 6
blue: let b3 = b3 + 1  ' blue = 5
brown: let b3 = b3 + 1  ' brown = 4
green: let b3 = b3 + 1  ' green = 3
yellow: let b3 = b3 + 1  ' yellow = 2
red: let b3 = b3 + 1  ' red = 1

sound 6,(50,100)  ' make a beep sound

' check to see if added to player 1 or 2
if pin0 =1 then addto2  ' jump if player 2

addto1: let b1 = b1 + b3  ' add score to 1
goto main  ' loop back & update LCD

addto2: let b2 = b2 + b3  ' add score to 2
goto main  ' loop back & update LCD
2. The current score is then displayed on the LCD, and the 'score' variable b3 is reset to zero. The program then enters a loop scanning each colour switch for a push. At the end of the loop the player toggle switch is checked to make sure the correct indicator LED is lit.

3. When a colour switch press is detected, variable b3 is loaded with the correct value for the colour of the ball, and then a beep sound is generated as aural feedback for the user. The value is then added to either player 1 or player 2’s score, dependant on the position of the player toggle switch. The program then loops back to step 2.

Summary

Students use LCDs every day on mobile phones, photocopiers, game consoles etc. By use of serial LCD modules students can incorporate this technology within student projects. By adding the clock upgrade to the module, projects that require accurate timing over long periods of time can also be easily achieved.

Further information about the serial LCD module can be found at www.rev-ed.co.uk

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Design and Make it - electronic products (revised edition)

Nelson Thornes

W hen I was asked to review this book I had already decided on which project idea, circuit and casing design I was going to do for my GCSE Electronics.

My first impression of the book was the clear illustrations of simple circuit design, with explanation of how it worked. It was colourful and gave a good presentation of information, that related to my project - an electronic combination lock.

I found very helpful the step-by-step guide from design through to fault finding and evaluation. This book contained a lot of specific information, which I needed to complete my project. I could not find any other book from my local library which contained as much detail.

Every student studying Electronics in Design & Technology should have access to one - a great asset!

Sacha Parker
Year 11 Pupil, The Nobel School, Stevenage

ISBN 0-7487-6079 £13.50
www.nelsonthornes.com
Introduction

Earlier this year as part of my Electronics AS-Level course we were assigned to do a piece of coursework. This piece of coursework consisted of creating a ‘simple’ electronic device from scratch and the inevitable mountain of ‘write up’ that goes with it. We had a choice of what to make ourselves so I chose to make a smoke alarm.

Research

My first step in research was to go home and open up my own smoke alarm, not to copy from, but to get ideas from etc. Unfortunately these types of smoke alarms incorporate a radioactive element called americium. Due to this I couldn’t get access to parts of the circuit as there was a metal cover covering the radioactive part(s) and if I were to lift the cover and tamper with it I could run the risk of letting the americium loose.

In theory it was still straightforward though, as all I needed to research was the smoke sensing part of the circuit as the other parts (latches, timers etc) that would be required I knew about as we had covered them in class.

So I started reading various electronics books and I went on the Internet. The most helpful source of information was a site called How Stuff Works (www.howstuffworks.com) and they had a section on smoke alarms it explained how there are two types of smoke alarm, there are photoelectric detectors and ionisation detectors. The latter incorporates the use of americium (same as my smoke alarm), which was not appropriate for my project. However the photoelectric detector type was feasible. A photoelectric detector is a component whose electrical properties change in accordance to the intensity of light it is exposed to. Therefore I was able to use a Light Dependant Resistor...
(LDR) and a light source to act as the smoke sensor. This works by placing them so that they’re facing each other, the smoke would gather in between them thus changing the amount of light going to the LDR thus changing its resistance. This change in resistance could then in turn be used to trigger an alarm.

**Design**

We were advised by our teachers to break the circuit into sub-systems, so that’s what I did. The benefits of this are being able to concentrate on one part of the system at a time, which would make it easier for me and reduce the amount of possible mistakes etc. So I started by making a list of features I needed/wanted from my circuit. Then using my findings from research and knowledge gained from lessons I decided on what components I needed etc. I split the circuit into sub-systems then constructed a block diagram and a wiring diagram on split supply rails to illustrate how everything was going to fit together.

**Sub-Systems 1 & 2**

**Light source & input sensor**

These two sub systems consisted of the smoke sensor (described in research) a 741 comparator acting as a switch. It also included a pair of resistors and a potentiometer (acting as a variable resistor), these components were used to manipulate the voltage going into the comparator so that when smoke was detected the change in resistance of the LDR would in turn activate the switch. I had a few problems with this due to the resistance of the LDR being hard to match with that of the potentiometer.

**Sub-Systems 3 & 4**

**Latch & reset switch sub-systems**

The signal given out from the comparator was fed into a latch, I used a latch because I wanted the smoke alarm to stay on until reset by the user. I used a nand gate bistable for the latch and incorporated a reset switch using a switch (n,o) and a resistor.

**Sub-Systems 5 & 6**

**Timer Sub-System & Alarm Sub-System**

Before the signal from the latch got to the buzzer it was processed through a 555 timer. The 555 timer acted as an Astable I used it in order to give a beep, beep, beep sound as opposed to a beeeeep sound. I also had to program the astable to oscillate at a suitable frequency by picking the right resistor and capacitor values. My friend advised me that 5Hz was a good frequency that was detectable by human hearing. As if it oscillates too fast all I will hear is beeeeeeep. So using the astable frequency equation I calculated what resistor and capacitor values I needed and then used the nearest actual values available to me. The output of the 555 timer was then fed into the buzzer.

**Sub-System 7**

**Battery Indicator Sub-system**

The battery indicator consisted of a LED in series with a resistor. When there is a power source present the LED will shine, when there isn’t a power source present it won’t shine. Thus indicating whether or not a power source is present/ working or not.

**Container**

I also had to design a container in order to shield the LDR from other sources of
light like sunlight, light bulbs etc. as they would obviously interfere. Using a cereal box I made a rectangular shaped container which did the job well.

Testing
I built each sub-system individually and tested them as I went along then tested the interfacing between each sub-system. I didn't use any special equipment just a multimeter.

Evaluation
I was pleased with my fully working smoke alarm it met its specification and I got a grade A for my project. It was really satisfying to see the end result after all my hard work, which also included a 15-page write-up. It was also satisfying to be using the skills and knowledge I obtained from this AS-level course to actually make something independently.

Citizenship brought to life by a new kind of museum

In June 2002 a new kind of museum, Urbis, will open in Manchester's new Millennium Quarter, close to Victoria train station. This unique educational environment will excite, challenge and inspire pupils and life-long learners of all ages, interests and abilities.

Four permanent floors of innovative and hands-on exhibitions tell the 'people story' of cities using leading-edge technology to dramatize the most far-reaching and significant experience in human history - urbanization. In 1800 only 5% of the world's population lived in cities - by 2020, this figure will have grown to 75%. The themed floors, entitled Arrive, Change, Order and Explore tell this story through an exciting blend of audio-visual, graphic and interactive exhibits.

Urbis will embrace a variety of learning methods and will provide a comprehensive education programme for pupils at Key Stages 2-4. The exhibitions bring to life the National Curriculum's new Citizenship course, as well as having good links with subjects including: History, Geography, Design and Technology, English, ICT, Art and Design and PSHE.

The education programme, which officially launches in September 2002, is being developed to incorporate resources and opportunities for the widest range of traditional and non-traditional learning groups. Information and activities will include: on-gallery events, workshops, building tours and teacher packs. Between September and December taught sessions on Citizenship will be available as an introduction to our wider taught programme which will be offered in 2003.

Further and higher education students will also benefit from the academic resources within Urbis. Students of Humanities and Architecture will be able to participate in a scheme of events including seminars and workshops.

Specially trained gallery 'Enhancers' will be on hand to further develop links with the National Curriculum and to help visitors make the most of their journey through Urbis. In addition the education programme will provide a series of gallery 'Maps', which will direct visitors along trails such as 'Citizenship' for schools, 'Fun' for families and 'Sensory' for people with mental and physical impairments.

The Urbis Management and Education teams are consultative and collaborative. The Education Team will develop resources, events and activities by working closely with teachers, families, group leaders and other individuals to ensure that learning objectives are delivered in new and exciting ways.

Elizabeth Usher, Director of Urbis, said: "The content of Urbis will be both dynamic and thought-provoking. I can promise that our visitors will enjoy a remarkable learning experience and that after a trip to Urbis, they will see their world differently." School parties will enjoy free admission. To plan and book your visit to Urbis call the Education Team on 0161 907 9077 or visit www.urbis.org.uk
School Inspection:
a teacher's guide to preparing for, surviving and evaluating Ofsted Inspection

Elizabeth Holmes

The Stationery Office

The topic might not be at the top of every teacher's holiday reading list, but this book should be a useful resource for anyone likely to be facing an inspection soon, with plenty to think about for those who have been through it all before as well as for NQTs.

Early chapters concentrate on the background to Ofsted and the purposes and processes of inspection, with details based on the current versions of official Ofsted handbooks. Subsequent chapters provide more practical advice and reassurance for teachers, with guidance on self-evaluation and planning as well as sections on what to expect during the inspection week itself. The book is of course not subject-specific, so there is little reference to practical work, for example, but the suggestions made are relevant across the curriculum. The effects of inspection on the individual, including health issues, are discussed in detail and there are suggestions for managing and limiting workload and dealing with stress. The book concludes with a chapter on what happens after an inspection.

This is definitely not a text for those looking for tips in a last-minute panic - at over 200 pages long it gives a comprehensive view of the whole inspection experience, from advance preparation to the actual event and its after-effects; I have to confess that at first I found the length a bit daunting. However, the presentation of information and comment is clear, with much use of boxed text and bulleted lists, there are plenty of examples and quotations to illustrate ideas and there is a good index - all of which contribute to making the book an accessible and readable guide.

Julia Cooke


Flowol

Data Harvest

Data Harvest

If you have a cupboard filled with LEGO Dacta® boxes sitting there because you, like us, have installed Windows NT4 and can’t use the LEGO Dacta®. Well, try using Flowol from Data Harvest. It is a flow chart based programming language, very easy to use and is compatible with NT 4 and the LEGO Dacta® boxes. The outputs and inputs work, the sequencing is very good, you can even have multiple flow charts, within the same sheet, working at the same time, a sort of Interrupt system. The slight downside is that the position sensor, as used with various arms within the Lego, is not as easy to use. It still works, but is more complex than the old waituntil [angle5 = 10] etc. You need to use a couple flow charts to count the rotations of the angle sensor. All help is provide by Data Harvest to achieve this.

The other main benefit of this software is the "Mimics" These are pictures, real or drawn, saved as *.BMP, that can be included in the flowchart and become interactive, with the mouse becoming an input device and small parts of the pictures changing, colours or shapes, as the program runs. The software comes with some Mimics, but others can be bought to suit additional needs.

There is a second piece of software that is currently under testing that can create the mimics. I found this software easy to use, though not idiot proof. I have created a number of my own mimics and found that after a few attempts it became easier to use. It is very easy to load them into the main Flowol program, just copy them into the correct directory, when you run Flowol they are ready to use.

Mark Gooding,
The Billericay School, Essex
Due to current teacher shortages an increasing number of us find ourselves teaching areas of D&T for which we are less prepared. This second version of Mike Tooley's CD ROM offers a number of interesting new concepts which will assist the teacher who is less familiar with electronics teaching. It offers a good reference guide to electronics which would also be suitable for pupils with a reasonable grasp of elementary electronics.

It is not an experiential circuit builder like Crocodile Clips. Instead it offers a more didactic and academic route into the study of electronics. It deals confidently with a range of more scientific principles such as Kirchhoff's law. However, some of these seem rather pedantic and indeed somewhat redundant when used alongside design based courses.

An interesting and excellent touch is a potential divider circuit with a superbly clear explanation of the associated formulae. There are also some very good interactive circuits along with accompanying worksheets. The half wave rectifier is particularly good and comes with a print out facility, so useful for producing worksheets.

The fault finding aspect of the programme is a very interesting tool. Within this, the voltmeter is obvious but I would like to see the addition of a resistance meter in version 3. I found that pupils needed guiding through each step of the way and the teacher has to create ways of achieving this in a group situation, oh well, life is never perfect! The contents tree on the L/hand side is clear and offers a good navigational aid through the long list on contents. My feeling is that it is rather clumsy to operate at times and not quite intuitive enough for some pupils. That said, this is a thorough encyclopaedia with excellent use of language and terminology. Good use is also made of video commentary, video clips and animations, all of which are of excellent visual quality.

This programme offers a wonderful ready reference tool for lesson planning and teaching. However, pupils of average or below average ability might find it difficult to negotiate alone. In my opinion it is a tool for teachers and students taking A level, GNVQ and Advanced BTEC courses.

Ben Barker Head of Technology, Tapton School Sheffield

Mad-Lab Technologies and Crocodile Clips have recently produced software and hardware that works well together to give pupils access to PIC technology. The software, called Crocodile Technology, is based on the now familiar Crocodile Clips and the hardware, PICLAB, is a neat little PCB that is a programmer and test-board combined.

When you load the Crocodile Clips programme you are presented with a screen that is similar to the original one, but there are some significant differences. Still included are the electronics and mechanisms, but added to the electronics is a PIC facility. This enables the user to simulate PIC action and build up circuits with a variety of inputs and outputs. To help explain how the systems work some simple cartoon-like animations can be added that depict pressure pads being stepped on, windows being opened, buzzers sounding and the like. The programming is done by means of a flowchart that is completed in a window selected from the Crocodile Clips menu. The facility also exists allowing the user to watch the program develop in BASIC. The software is straight forward enough to use, but there is a lot there and it is advisable to take sufficient
time to become thoroughly familiar with it. The user can select from a range of programmers to download the program to.

Another feature available in the software includes a picture section, which has a range of simple electrical components. The motor that actually slows down when you switch it off impressed me. In this feature the familiar 'component blowing up' effect is only accomplished by adding a fuse. I think the picture feature would be useful and very visually effective projected onto a screen when teaching basic circuit theory. There are also sample circuit blocks in the original format that have pre designed circuit elements ranging from transmitters and receivers to switch de-bouncing circuits.

The programmer/test board I tried is called PICLAB and is manufactured by MadLab. Their web site at madlab.org is worth a visit and there is software to download. The board connects to the computer via a COM port and can be accessed directly from the flowchart screen. The test board has a selection of inputs that include push buttons, sound and light detectors. The outputs include a dual seven segment display a buzzer and eight LED's to flash on and off. The big advantage is that the programmer and the test-board are in one, so there are fewer circuits to mess about with which will be an advantage as far as managing resources goes. Also, the cost of the programmer and test-board combined is very competitive.

Although there is a lot more to the software this review is primarily aimed at teaching PIC technology. As far as PIC programming is concerned both the software and hardware are straightforward enough for students get to grips with. Aimed at KS3 and KS4 the PIC programming software is not designed to be a complete solution for the teaching of PIC programming above that level. However, it would be a useful introduction at any point with the circuit simulations being a useful feature. If you want to use the same hardware at post sixteen the programmer will work from any program that will down load a hexadecimal file. I successfully downloaded files onto a 16F84 PIC from a hex file that flashed a sequence of LED's on and off and played a range of tunes on the sounder. They will never make the hit parade, but they made the point.

I can recommend both the Crocodile Clips and PICLAB programmer as worth a closer look.

Jim Young
Wilnecote High School
Staffordshire

Maplin puts the spark back into electronics

Maplin Electronics has announced the launch of its second national initiative to promote electronics teaching in secondary schools. The decision follows recent education debates concerning the provision of vocational training in Britain and, in particular, reports that the numbers of HND students in electronics have dropped by 25 per cent, with those starting degrees in electronics also decreasing.

The focus of Maplin’s initiative, which was trialled in schools across the country for the first time last year, is a free teaching resource that has been tailored to meet the objectives of Key Stage 3. Compiled by Maplin’s technical experts in conjunction with teachers, it includes detailed lesson plans for pupils of all abilities. Also included is the ‘Search for Tomorrow’s Inventors’ competition which is designed to encourage innovation and to serve as an opportunity for pupils to apply what they have learnt in a fun way.

‘The response from teachers following last year’s initiative was really enthusiastic and the feedback has been extremely valuable in compiling this year’s resource’, commented David O’Reilly, Maplin’s Marketing Director. ‘The major change in response has been a closer tie-in with the National Curriculum and, in turn, a more specific target user, namely pupils at Key Stage 3.’

Maplin has also launched a website dedicated to education: www.maplineducation.com. Here, teachers and pupils can gain additional support, access lesson plans and download project worksheets.

Teachers who would like to receive the pack should contact Liz Kirkham on 0117 9493394.