SCOTTISH SCHOOLS SCIENCE EQUIPMENT RESEARCH CENTRE

Bulletin No. 144 **February 1985**

MFA - Review

A D D R E S S   L I S T

SSSERC, 103, Broughton Street, Edinburgh, EH1 3RZ Tel. 031-556 2184 or 031-557 1037.

The Association for Science Education, College Lane. Hatfield, Herts. AL10 9AA
Tel. (07072) 67411.

Newbold & Bulford, Carlton Park Industrial Estate, Saxmundham, Suffolk, IP17 2NL
Tel. (0728) 2933.

Unilab Limited, Clarendon Road, Blackburn, Lancs. BB1 9TA Tel. (0254) 57643 or 57644.

INTRODUCTION

Auf weidersehn tech.!

With this issue we say farewell to Bill Divine, Electronics Technician at SSSERC. Bill joined the staff in September, 1974. We will greatly miss his breadth of experience spanning the development of electronics technology across forty five years. Brought up on bottles (valves to the innocent) he has spent the latter part of his working life on chips. Perhaps that other part of his life, on a diet of very little, as a P.O.W. on the Burma railroad, explains his catholic tastes and healthy appetite for things new and interesting.

Bill's other great strength is an abiding passion for matters photographic. This has been a definite asset to the Centre over the last ten years. It has also proved a boon to the many visitors and correspondents who have received the benefit of his sound, down - to - earth advice on photographic techniques and equipment. His camera and darkroom work have also been beneficial to the wider technical reputation of this Centre, his SSSERC entries for IST and other competitions having brought him a prize or two.

For his patience and self-effacing manner, his willingness to muck-in and his appetite for work, all the staff will greatly miss him. The same qualities have also endeared him to many school technicians, whether at SSSERC courses or on the end of the telephone. We wish him and his good lady a long, healthy and happy retirement.

Easter closure

We hereby give notice that the Centre will be closed from the end of business on Thursday, 4th of April until the morning of Tuesday, 9th of April, 1985. Please note that there will be no Saturday opening on the 6th of April. There will be no lamb's blood on the door either. My diary tells me that the 6th is Jewish Passover but that is mere coincidence!

Scottish Region ASE Annual Meeting, 1985.

This year the Regional Annual Meeting will be held in Dundee College of Education, from Tuesday 9th to Thursday 11th April. SSSERC will be exhibiting as usual. Ian Downie, SSSERC Research Fellow in Microelectronics Applications, also hopes to be there. Ian will exhibit some of the results of his work and be available to hear, and discuss, teachers' comments on the SSSERC Microelectronics Project.

Cost Index

Our cost index for consumable items is sampled twice yearly in May and November. The 100 baseline was set in May, 1974. For the six months from November, 1983 to May, 1984 we reported the first ever downward movement - a fall of approximately 13%. We assumed that this was the result of intense competition and price cutting in the school science consumables market. We also warned against reading too much into one set of figures (as the economic commentators are wont to say).

Well, the index is on the move again but only just. A very small increase was recorded for the six months to November 1984. This was of the order of 0.7%, the index having moved up from 274.7 to 276.54. This still leaves the annual percentage figure, November to November 1983-84, standing at approximately minus 13%. It will be interesting to see by May this year any effect on the index from the recent increase in monetary entropy*.

*[Was this an alternative manifestation - a Sterling Hot Air Engine?].

Biochemical Society - Schoolteacher Fellowships

The Biochemical Society is sponsoring a number of fellowships for teachers in the British Isles. Fellowships are tenable at universities in the UK and in the Republic of Ireland. The purpose of the awards is to give teachers an opportunity to take part in research and to update their knowledge of biochemistry.

Awards are for one term (3 months) and include a stipend of £500 plus an allowance of up to £500 for travel and other expenses incurred during the tenure of the fellowship. In addition a contribution will be paid towards the cost of the research to the host department.

Any aspect of biochemistry may be studied provided that the area of interest chosen has been approved in advance by the Head of the Department where the teacher wishes to conduct his or her research.

Applications should be sent to the:

Executive Secretary,
The Biochemical Society,
7 Warwick Court,
London WC1R DP

There are no special forms, but in addition to personal particulars and a brief curriculum vitae, applicants should include an outline of the work they wish to carry out, the dates of the proposed attachment, and a letter of support from the head of the host department. The closing date for receipt of applications for terms in the 1985/6 session will be 15th May 1985.

Microelectronics monographs

As this Bulletin is being compiled copies of the first microelectronics monograph title " Memo 1 - Constructional Techniques" should already be in Scottish schools and colleges. These monographs are being prepared by Ian Downie our Research Fellow in Microelectronics Applications. They are being distributed initially by the Scottish Curriculum Development Service (SCDS), Dundee Centre. Two free copies are being sent to each Scottish secondary school, one for each of the science and technical departments. Extra copies are available from either SCDS or SSSERC at £1.50 per copy including post and packing.

Distribution lists are notoriously imperfect. We would entertain sympathetically, as they say, any claim from Scottish EA or independent schools that they have been overlooked in the general distribution of copies. The fly ones amongst you should bear in mind that such claims can be cross checked against the mailing records of SCDS. Such naughty claims will be summarily dismissed!

Orders totalling less than £10 <u>must</u> be accompanied by a Sterling cheque or postal order, crossed and made out to "Dundee College of Education (for orders to SCDS) or to "S.S.S.E.R.C." (for orders sent to us). "Memo 1" may also prove of value for pupil use and in TVEI centres etc. Depending on demand, it should be possible to offer discounts on bulk orders. These would be made possible by lower postage costs for bulk handling and mailing. Whilst sufficient copies remain available, orders for class sets of Memo 1 will be handled at a price of £1 per copy.

The biter bit?

After our recent piece in Bulletin 143 on "Technicians and the Bulletin", we received the letters partially (in only one literal sense) quoted below. I must point out that both letters came from the same school. Can you have a conspiracy of two?

The first of the letters quoted was dated the 8th and the second the 7th of January, 1985:

"Dear Editor,

With reference to the "Mushroom" system of communication, I feel obliged to say that the technicians in my department keep me fully informed of the contents of SSSERC Bulletins; why, they even let me have a glance at the "November" (1984) issue a full month before my own copy arrived (yesterday).

Yours in manure,

etc.,"

"Dear Sirs,

I thank you for the November 1984 Bulletin which I got today. I note your remarks about the Mushroom system of communication and would suggest that the 'Carrier Snail System' is equally undesirable.

Yours faithfully,

etc.,"

I am loth to spoil to the fun but must curtail this manurial mudslinging. Let us thus cut the compost and come, and hopefully remain, clean. Most Scottish state schools receive their Bulletins by a bulk distribution system. This utilises the internal mail or "wallet" sytems used by many Local Authorities. Bulk parcels of bulletins left the Centre in the first week of December, 1984. However, a small number of enlightened senior/chief technicians in Science Centres have requested, and pay for, a special parcel to be sent to them. They then distribute copies to the science technicians in that Region or Division.

So, the moral possibly is that the "Carrier Snail" is preferable to the "Mushroom" but that a smaller snail is quicker on its foot!

No comment

"The committee will also try to find money during the course of the year for an extra child psychologist and careers officer and to meet the non-teaching costs of repairing material for the standard grade courses"

'Times Educational Supplement Scotland', 1st February, 1985.

*   *   *   *   *   *

OPINION

Kits in technology education

In olden times there was a branch of mathematics, much favoured by schoolmasters, which was called Euclidean geometry. A study of that subject was characterised by problem solving, a correct solution often being attainable by several different means which each depended on a set of rules acquired within the course. Thus a pupil working on problems within book 4 of the course knew that the solutions were dependent on rules found between the beginning of book 4 and the place he or she was currently at, and also on the rules picked up in books 1, 2 and 3. The essence of that problem solving was the application of knowledge founded on the course. Now it would seem that a technology course based on a kit of parts is the present day equivalent of Euclidean geometry. We might call it Euclidean technology. It's self-contained; it does not require using concepts which are outwith the course; it does not, as we have elsewhere less crudely put it, cause pupils or teachers to get off their bums. Is this the sort of technological activity required of secondary education to bring about the revival of British industry?

A potential fault of any technology course based on a kit of parts is that it may not extend into the sloppy, messy world of other things. It may encourage that pernicious and debilitating national disease called sloth. Sloth in thought and action. It is easier to answer than question. It is less taxing to solve textbook questions and make do with what equipment is provided than get up and do on the basis of questions one has asked oneself.

Creativity and imagination were required of serious students of Euclidean geometry, but their thought was restricted, utterly, to what was in the books. The student is never required to dip into that part of the world not contained within the course. It is in this sense that there could be a parallelism with a kit-based, technology course. There is a danger that the creativity and imagination engendered by a technology course will be as encapsulated in kit form as surely as it would within that geometry course, written in ancient Alexandria. We would point out that an aim of technology education should be to enable a pupil to relate theory, skills and experience to practical application of any kind.

Another criticism which can be levelled at Euclidean geometry is abstractness. Application is imaginary. In contradistinction, one of the major factors for technology education is the espousal of that intermixture of theory, skills, experience and application, the things we have just been writing about. It cannot be doubted that this intermixing will take place in a kit-based course, but the sole reliance on a kit may impose limitations to the detriment of the overall aims of technology education. As to what the overall aim should be, that is the sixtyfour thousand dollar question. It all hangs on two words, 'on' and 'doing'. Should it be **on** technology, or should it be **doing** technology? In our opinion there are more than enough school courses on things and not enough doing. A danger of kit-based practical work is that as it can be superb at 'on' work, in demonstrating with clarity the abstract principles, it pressurizes the overall aim of technology education away from the practising of technology.

We are not against the teaching of technology with kits, but we would question the wisdom of basing a technology course solely on practical work with kits. It is important that a kit-based course is extended to involve non-kit work either using whatever materials and ideas there are to hand, or material and ideas which lie outwith the course but of which the pupil has experience, or materials and ideas new to that pupil which he or she chooses to work with. The word 'materials' can be taken to mean components, systems of components, or manufactured equipment; the word 'ideas' can mean any concept, set of rules, skill or body of knowledge, not necessarily having been described beforehand within the course.

There is another side of the Euclidean pedagogy which we will mention in passing, the structured, bottom-up approach, where knowledge is released to pupils in parsimonious helpings, but of course in a structured, sequential order. We are not tarring all kit-based education with this brush and it is refreshing to review, for this bulletin, an electronics course which eschews a structured approach. Kits can be used for unstructured work; it is not the fault of their designers if kits are used otherwise.

The benefits of kit work are known and obvious. In particular may we mention the removal of perception difficulties associated with relating diagrams, layout and system function; the diminution of manipulative difficulties; the speed with which a practical solution can be realised or an error put right. In addition there is presently a requirement for simple, well designed materials for technology teaching which can effectively be used by unskilled staff. Kits have a place here. This is a pragmatic solution to a practical problem that must be faced; there are not enough teachers with sufficient depth of relevant experience to be able to help pupils with open-ended work.

If a technology course is based wholly on kits it is the limitation on thought and action that may result which we warn against. One of the pressures being brought to bear in the movement to bring technological studies, be it as named, or electronics, or biotechnology, or whatever other technology, into the curriculum is the desire to give pupils open-ended, practically based and problem solving, project work. It would be ironic if this movement unintentionally resurrected Euclid.

*   *   *   *   *   *

CLEAPSE Guides

We have recently received the following new or revised publications from our sister organisation, "CLEAPSE School Science Service". Copies of these publications may be borrowed for up to one month by application to the Director of SSSERC:

a) New Guides

L4c "Linking Balances to Computers"

L85a "Electronics Teaching Kits".

b) Revised documents

L86 "Electrical Safety for the Users of School Labs". Part 1: Essentials for Everyone, folded A3 intended also for use as a poster; Part 2:For those wanting more information. [A revision of the CLEAPSE Guide also published for a time by the ASE].

L127 "Photography" [A substantial revision of the earlier guide].

L144 "Precautions with Mercury"

BUR d-i-y burette repairs.

PUM Aquarium aerator pump maintenance.

WAT Stopclock and stopwatch repairs.

*　　*　　*　　*　　*　　*

SAFETY NOTES

Accident report

metal oxide reduction

A school reported an accident to us just before Christmas and asked us to relay it in the Bulletin in case others carry out the same procedure.

Fortunately no one was hurt when the teacher was pre-testing the demonstration during his lunch hour. A crucible filled with a mixture of zinc powder and copper(II)oxide was being heated when the crucible shattered violently, the detonation being heard by a colleague four floors down.

Some solid state reductions of metal oxides by other metals can be quite violent, especially if the oxide of a metal low in the 'activity series' is being reduced by a metal high up in the series and if both are finely divided. However these reactions do provide a very useful and a simple picture of the 'activity series' on the basis of finding out which metal will 'rob another of its oxygen.' This approach is more down-to-earth than the more abstract order of displacement of metals from aqueous solutions of their salts. It also provides a marvellous opportunity for pupils to have a guess at the likely order of the affinity of metals for oxygen based on their everyday experiences and then design experiments to test their hypotheses. Of course the teacher will need to be advised of any projected experiments and in some cases he will need to demonstrate or even veto them. For the most part their guesses will be correct, but a few interesting surprises will emerge.

For reasons such as these we feel it would be a shame to 'ban' these types of experiment. They can be carried out safely provided:

(i) that only a small scale is employed,

(ii) that the mixture is loose and not confined inside a container. A small spatulaful heated on ceramic paper is one way of achieving this,

(iii) other normal precautions such as the use of safety screens are used,

(iv) certain metals are excluded altogether and others restricted to teacher demonstration. Obviously the alkali metals and calcium would be excluded. Aluminium, magnesium and zinc powders should be restricted to teacher demonstration. Pupils could try reducing the oxides of copper, tin, lead,iron, aluminium and magnesium with iron, tin, lead, and copper in such open-ended investigations. Zinc powder could also be used in conjunction with the oxides of iron, magnesium and aluminium with small scale methods.

(v) very fine grades of metal powders are not used. In addition some metals and their oxides are quite hygroscopic and are best dried before use.

One method used for many years by a member of SSSERC staff and by his teaching colleagues is described below:

A very small quantity, never weighed, but what would cover the end of a spatula containing equal quantities of copper(II)oxide and either magnesium or zinc powder was placed on a gauze supported on a tripod. A lit bunsen was then carefully shoved under it with the aid of a metre stick. A reaction occurred vigorously, but safely and the brown/pink colour of copper can be observed. It also works satisfactorily if the reaction mixture is placed on a piece of ceramic paper (asbestos in those days) resting on top of the gauze.

We are grateful to the teacher and his school for informing of this mishap. The pre-testing of any 'doubtfuls' is seen to be most prudent.

B I O L O G Y   N O T E S

Stomatal counts, technical tips

Comparative studies of upper and lower leaf surfaces, and of leaves from different plant species, can be most rewarding. Such studies combine anatomical, physiological and ecological considerations. One type of data of significance here is the number and distribution pattern of stomata. The traditional method is by a leaf peel technique. This usually employs a common enough and easily obtainable material, nail varnish. However this material has one specific disadvantage, it can be, in the wrong hands, very messy.

We have recently been trialling an alternative technique based on the use of 'cellulose acetate' sheet and propanone (acetone). The tip was passed on to us by Mr.Duncan Herd, then technician at Balerno High School and now at Stevenson College, Edinburgh. Duncan was shown the method whilst attending an Open University Summer School. Stomatal counts form part of the OU Second Level Biology Course. The technique outlined below was suggested by Phil Parker, O.U. S202 Course Co-ordinator. It is very similar to the technique used by paeleobotanists to section fossils by acid etching followed by taking an acetate peel. Indeed, from the dim and distant past, the author even remembers being taught this method. He just didn't have the nous to make the transfer to living tissue!

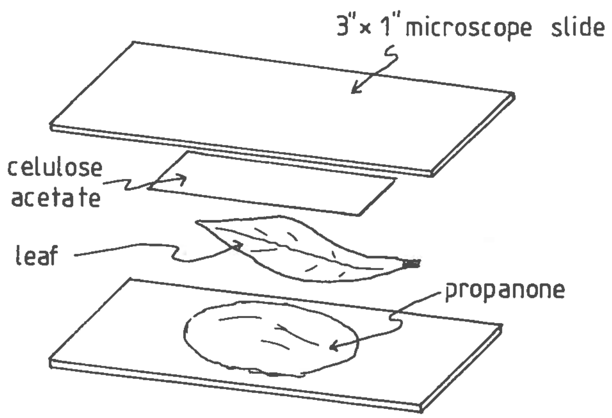

Fig.1

The sequence of steps should be fairly obvious from Fig.1. The leaf under investigation, or part of it, is placed on a 3 X 1" glass microscope slide. Using a transfer pipette, a small volume of propanone sufficient to cover the leaf is then added. This is quickly followed by a piece of cellulose acetate sheet somewhat larger than the leaf. A second microscope slide is placed on top to form a sandwich. If necessary a weight can be placed over all to prevent the leaf curling. The solvent is given time to evaporate, the sandwich dismantled and the leaf peeled away from the acetate. The acetate, together now with its impression of the leaf surface, can be mounted on one of the slides and studied microscopically.

We have tried the technique out and can confirm that it is simple, quick and very effective - once you have found the correct materials. The obvious source of acetate sheet is an offcut from overhead projector transparency material. However not all such materials are soluble in propanone. There's 'acetate' and there's 'acetate' apparently. Materials of the type used to make transparencies from prepared plain paper masters in a thermal- or photo-copier appear unsuitable. However, we successfully used pieces of 'di-acetate/tri-acetate' sheet of the type meant to be drawn on directly with water-based or spirit pens. We also used tinted sheets of Cinemoid but this is relatively expensive, even compared to o.h.p. material, or buckets of nail varnish. A yellow or other pale tint is best but even clear sheet gives acceptable results. With clear sheet you could at least try out some of the simple contrast enhancement techniques from past issues of the Bulletin [1].

The other ingredient, propanone, also needs care. Use fairly fresh stock. If old laboratory stock of this solvent is used it may have been contaminated with water vapour and be slow to evaporate. In that case you may find that too much acetate dissolves and that you end up with a leaf/acetate sandwich, the leaf being completely embedded in the acetate. In addition propanone is highly flammable. Only a very small volume is needed per leaf peel. Nonetheless proper attention should be paid to ventilation, removal of sources of ignition, and careful handling.

The other nice thing about this exercise is that it introduces an opportunity to attempt one aspect of microscopy too rarely practised in schools - quantitative work. Very few students, or teachers for that matter, know even roughly the size of the field of view of each objective on the school's microscopes. Here is an ideal time to find out. Stomatal counts could then be expressed as mean numbers per unit area of leaf surface. The approximate field of view of an objective is easily determined even in the absence of expensive stage micrometers and graticules. A piece of mm. graph paper on the stage can serve as a rough guide there and inexpensive photographically produced eyepiece graticules are available from Philip Harris [Cat.No.B32200/9 in packs of 10 £5.55].

Reference

[1]. SSSERC Bulletin 94.

Microscope spares, again.

Following our article in this section of Bulletin 143, we have had further discussions with Newbold & Bulford about spares for Carton Optical microscopes, notably the model C and CA. We have now received updated information, on spares availability, via Mr. John M. Ingram, the Scottish representative of Newbold & Bulford (and, interestingly, of Charles Frank Ltd. now also merged with that firm). We think it best to quote Mr. Ingram:

"A selection of spares such as racks, pinions and mirrors are kept at our head office in Saxmundham but any parts not held by us could be obtained from the manufacturer in a reasonably short time. We are able also to obtain spares for the now obsolete model C microscope."

The head office address referred to, and that of Mr. Ingram, are given on the inside front cover of this bulletin.

Based on a number of reports of the supplying by several firms of wrongly dimensioned spares, our advice is to send full details of relevant sizes for spares such as mirrors and mirror shafts, racks, etc. Better still, if you have one, send an actual sample and order "A replacement for one of these please".

* * * * * *

E Q U I P M E N T   N O T E S

Microelectronics For All (MFA)

Evaluation of course materials

Introduction

MFA is a short course on digital electronics produced by the Microelectronics Education Programme (MEP) of England, Wales and Northern Ireland. It is aimed as a first experience course in this technology for pupils of wide ability range in early secondary years, specifically for 11 to 14 year olds.

The course materials have been prepared in open learning format; that is to say they are self contained and self sufficient. Many pupils will be able to follow the notes independently and will not require instruction from a teacher. The electronic equipment is self contained. Equipment additional to that which is contained within the kit of parts is not required unless it is planned to diverge into applications which lie outwith the course.

And as a pupil is expected to master the course on his or her own, so indeed can this be expected of a teacher who lacks specialist knowledge in electronic engineering. The aim of the MFA producers is that the material "is sufficiently supportive so that any teacher, from any background, could feel confident in presenting the course." It is our opinion that this aim is right and its expected outcome will, in most cases, be met.

The resource materials on which the course is based are

- pupil work cards giving core and extension material
- teacher's manual which includes
  - activity sheets giving optional, additional material to reinforce, by classroom based or homework exercises, the other course work
  - leader's notes
  - model answers
- three basic modules - Decisions', Counter and Memory
- extension modules - Movement, Music and Computer
- batteries, leads and storage trays

The pupils' and teachers' notes (Fig.1) have been produced jointly by Hobsons Limited and the Careers Research and Advisory Council (CRAC). The equipment is manufactured by Unilab Limited and the complete kit, notes and hardware, is supplied by this latter firm.

Teachers may feel miffed at the reference to "leader's notes" (the terms "leader's" and "teacher's" both appear in the supporting text). If, however, it is thought desirable to bring technological activities in general and microelectronics in particular into the school curriculum then this is probably the way it can most readily be done. It will be a long time before there is a body of teachers of engineering in the profession to provide the level of teaching which other parts of the curriculum apparently enjoy.

The course is deliberately poor on content and rich on process, the central process in the course being design. It is pointed out in the introduction to the Leader's Notes that the ability to solve practical problems is far more important than the ability to remember the truth table of an AND gate. In this view we concur.

General comments

Each of the Module boards has a standard layout of three sections which, with varying degrees of success, split their function into

i) input, ii) processing and iii) output

The Decisions' Module appears the most successful in this regard, with the Counter Module less so, and the Memory Module layout as somewhat confusing. These opinions are enlarged upon at a later stage in the report.

In the introductory work card to each module there is an invitation to the pupils to press, switch and experiment "to see what happens". However the overall design and construction of the boards renders damage unlikely from naive users and the point is borne out by the evidence from the one Scottish establishment that, to our knowledge, uses the boards.

The power supply for the modules is a 6V, lantern type battery. Unilab have designed a neat locking cap to act as the battery connector. All three modules can be powered from a single battery, one module slotting into another with

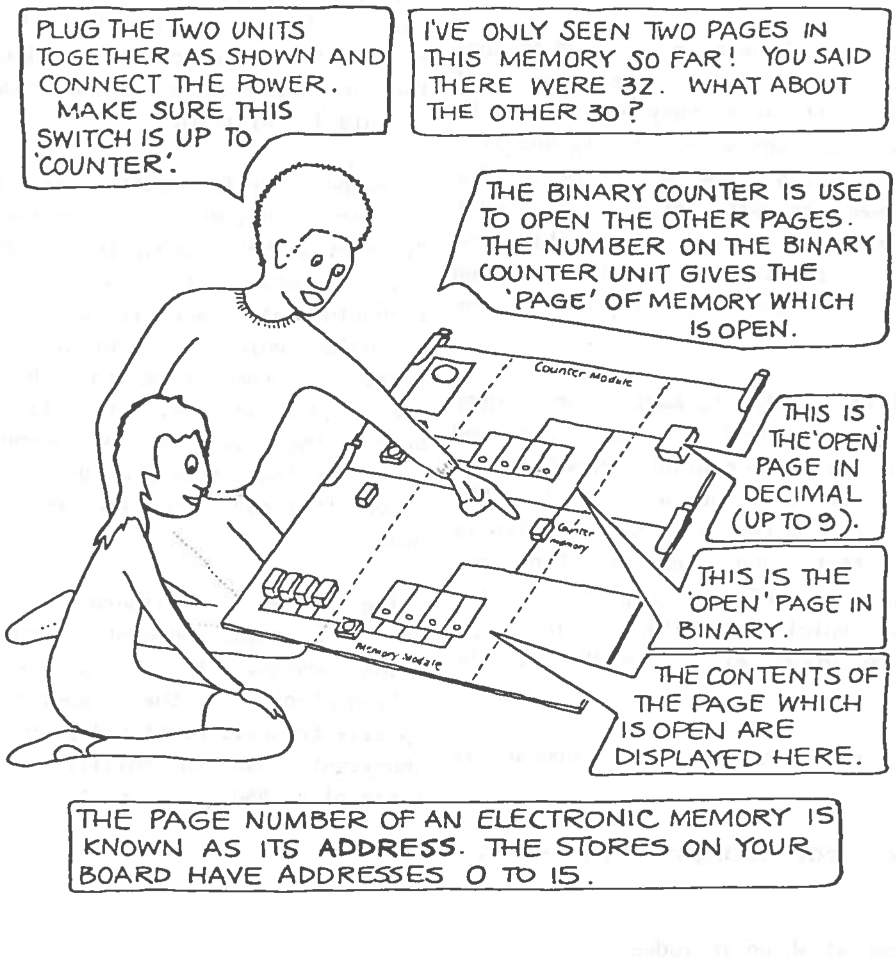

Fig.1

metallic clips acting as power rail conductors.

2 mm sockets are used on the modules so that electrical connection can be made from one part to another. This size of socket is in keeping with the overall size of the boards. Leads, of various lengths and colours and with stackable plugs, are supplied as part of the kit.

C-MOS integrated circuits are used. The boards will work satisfactorily provided the battery voltage remains above 4V. A supply in excess of 6V must not be used. A mains operated supply can be used provided that its output is a regulated 5V d.c.

solution to a practical problem. It ensures they are neither side-tracked nor misled by too detailed means of achieving an end.

Decisions' Module

The circuit board comprises three clearly marked sections, i.e. inputs, logic gates and outputs (Fig.2). Inputs can be obtained via four different methods, i.e. slide switch, light sensor (LDR), temperature sensor (thermistor) and push switch, these sensors being used as digital devices. One criticism of the choice of temperature sensor is that it has high thermal inertia, leading to a time delay before temperature changes affect its

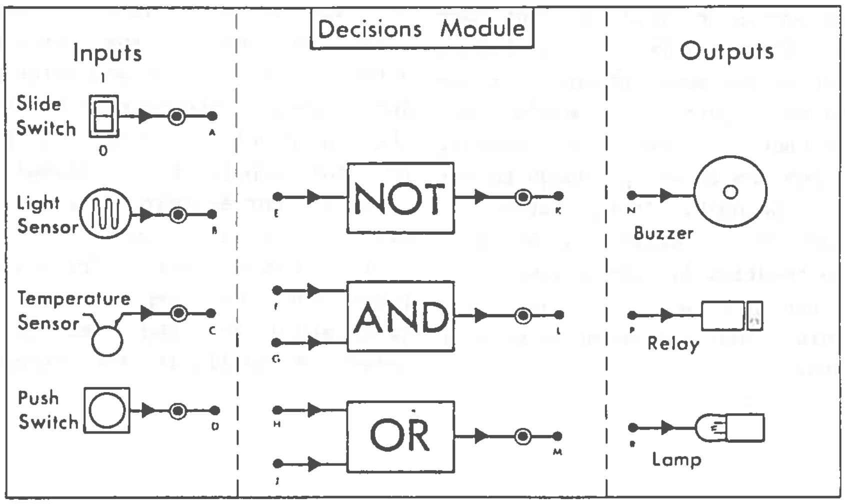

Fig.2

Details of component pin-outs, together with the provision of supply and ground connections, are hidden from the pupils. There is no direct wiring up of components, as practical work is entirely based on a systems approach, connecting sub-systems to form bigger systems. Thus one outcome of the course is that whereas on the one hand pupils will attain a certain proficiency in working with digital electronic systems, on the other hand they will not have picked up any knowledge whatsoever on working at component level. This feature is intentional. It lets pupils concentrate on design and on getting a working

output. This would have been avoided by choosing a miniature bead thermistor. The two sensors could be more constructively used if on flying leads and it is a pity that they have been mounted on the surface of the board as this debars the pupil from tackling many practical applications. For example a temperature sensor could be placed in a beaker of water which experiences a change intemperature; a light gate could be positioned to detect the presence of a vehicle for timing or control purposes.

There are three gates in the processing part, AND, OR and NOT. We commend this restricted choice of gates as there is no need, in an introductory course, to delve into the negatives of NAND and NOR. Indeed, the logic of these gates can be achieved by negating the output of the AND and OR gates.

The output section has three elements, a buzzer, lamp and relay; this latter item having a terminal block connector for operating a peripheral device.

The first three workcards examine the operation of the gates as separate units. This develops into sensor, gate and output combinations of gradually increasing complexity. Learning is largely achieved through coping with practical problem solving. Not, may we emphasise, that abstract form of problem solving that children are thirled to expect on the mention of the word 'problem', whose response is the opening of jotters. It would seem, from our limited feedback from the trial school, that the spread of problems is wide enough to tax the most able whilst being highly motivating for all. A sample problem from the course is "Design a circuit which will automatically turn a lamp on at night, but can also turn the lamp on at any time with a switch. This type of system is used to control street lights."

Counter Module

The board (Fig.3) contains a 4-bit, resettable, binary counter with two displays, 4-bit LED for binary counting and 7-segment LED for hexadecimal or decimal counting. Clocking can either be done manually with the Count pushbutton or automatically with the Pulse Unit.

The module starts with the concept of binary numbers and how to count in binary by use of the Count button and 4-bit LED display. This leads into use of the Pulse Unit for automatic counting and the idea of an automatic reset. It is at this point that the knowledge gained from the first module is applied to new situations involving both the Decisions' and Counter Modules. By means of the gates it is possible to apply an automatic reset at many steps between 2 and 16, or alternatively to stop and latch the count at one such step. In the opinion of the reviewer this is the high point of the course; problems presented to the pupils being stimulating, taxing and numerous. For example "Design a central heating system with a 'clock' (the counter) which resets at 12 and which switches on a water pump (with the relay) when the temperature sensor is at room temperature and the time is between 0 and 3 or between 8 and 11. If the temperature is high or

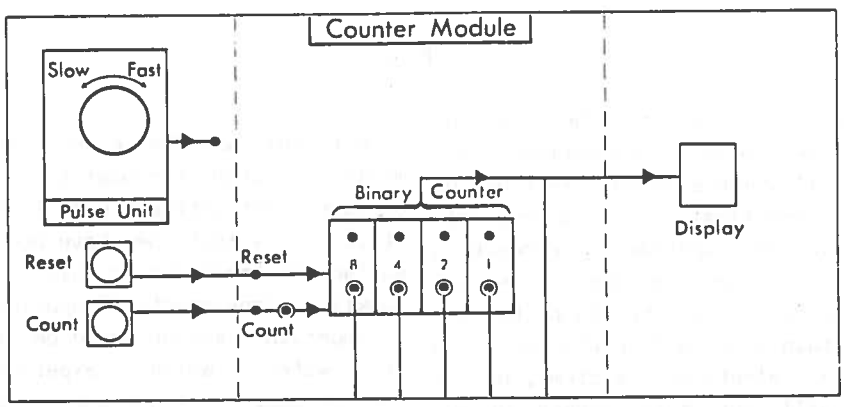

Fig.3

the time is between 4 and 7 the relay should be off."

The layout of this board is perhaps not quite right. A case could be made for moving the 4-bit binary display and sockets across to the right hand, output side of the board. Perhaps its binaryness is the reason that the designers have placed it in the processing part, or perhaps there was just nothing left to leave in its place. This criticism of layout should be qualified and muted by our finding that, in operation, the board is very easy to work with and the layout seems to place no impediment in use. The point should therefore be made that it is fatuous to attempt to mould, come what may, all things into one set pattern. It is the degree to which pattern moulding is taken that requires care.

Memory Module

The processing unit (Fig.4) is a 32 address random access memory (RAM), each address being thus labelled by a 5-bit number.

counter to address the 4 least significant bits of the RAM; the counter being clocked either manually or automatically. The most significant memory bit is set by a slide switch on the Memory Module, this slide switch being called "Memory Select". We will return to this choice of name later. Sockets have been provided on the five address lines. These can be wired to other parts, in particular to points on the Decisions' board, and this provides the alternative means of addressing. By this second means it is possible to construct a look-up table on binary arithmetic, or a light sensitive controller which provides one course of actio n in daylight, another in darkness.

Reference is made in the pupils' work cards to "page" and "paging". To begin with the terms are used analogously to pages in a book and then developed into the literal concept of paged memory. The message conveyed is that each address is a separate page. Whilst this is correct in the sense that a page of memory, like a bit of string, is as long or as short as you want it to be, it is not standard usage. We normally think of a page as being a block of memory; not one address but several. This concept of page could have been readily conveyed by blocking the 32 address memory

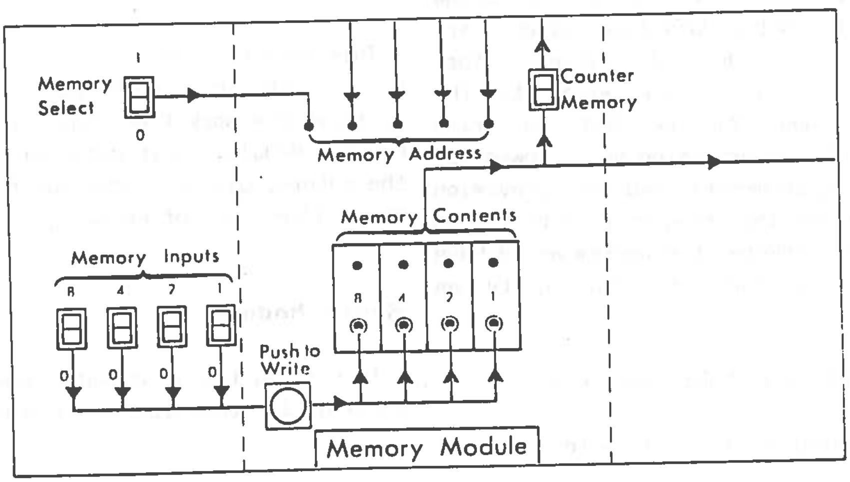

Fig.4

Memory addressing is done by one of two means. One of these involves using the 4-bit binary

into two 16 address pages; memory being paged by operation of the Memory Select button which controls the most significant address line.

The 4-bit data port of the RAM is sited in the central, processing part of the module board. Its situation is confusing though we can understand why it has been placed there. One reason would seem to be that as data is stored in memory as a binary number it can be thought of as part of the processing. Another reason is that data lines to memory devices are usually bidirectional. Where better to place the data port than pig-in-the-middle? This point of ours might have been resolved better in other ways. The port could have had two sets of terminals, one on the input side by the slide switches, the other on the output side. Alternatively it perhaps should have been recognized that it is not always possible to simplify and mould all systems into the one pattern of input - process - output.

All the examples and problems given treat the data-port sockets as outputs. The design prevents them from being used reliably as inputs. It is our opinion that because the data-port sockets are not obviously only for output, pupils will experiment with them in their input mode and get results which are confusing.

Data is written to memory by a two stage operation. (1) The 4-bit data-line switches are set or reset in the desired pattern (or, illicitly, other devices are wired to the data-port sockets), and (2) the Push to Write button is depressed. One provision not allowed for is automatic writing to memory. Had this provision been made, and for the inputting of data by wiring to the data-port sockets, the system would have been capable of data capture. This opportunity has been missed.

Concepts covered by the Memory Module are

memory addressing, with facility for automatic addressing

writing to memory

reading from memory, with facility for automatic reading

programming; memory based control and production of look-up tables

All three modules can be joined together to produce an array of facilities which allow many diverse applications. There is the customary "traffic lights sequence" and a "date of birth storage" program, as well as control sequences of a more interesting nature. For those who persevere to this stage, and we do not doubt that many will strive to do so, the reward, apart from self satisfaction, is outlined as "You are now a fully qualified design engineer!" It would be churlish of us to disagree.

There are two supplementary modules which connect to the output of the Memory Module. These form the basis of extension material on programming and control with this module.

Movement Module

This is a Lego buggy, with two motors, attached by an umbilical cord to a control board which slots into a socket on the output side of the Memory Module. 4-bit data held in memory controls the motors, giving independent control (on/off, forward/reverse) of each.

Music Module

In varying the 4-bit data from memory by up to a total of 16 steps simple tunes can be programmed.

What it costs

MFA material is supplied as a full class kit which provides enough material for ten groups of children. Prices of the two Packs referred to in the review are given below. For the full price list please enquire of the suppliers, Unilab Limited.

	cat. no.	price	description
Pack A	540.101	£829.19	hardware for full class kit
	540.201	90.00	full Workcard set and Teacher's Book
Pack B	540.102	496.79	hardware for Decisions' and Counter Modules
	540.202	66.00	relevant Workcard set and Teacher's Book

List of hardware in Packs A and B

	Pack A	Pack B
Decisions' Module	10	10
Counter Module	10	10
Memory Module	10	1
Movement Module	3	0
Music Module	3	0
Lantern battery	13	10
Battery holder	13	10
Leads (2 mm)	60	60
Vehicle set	3	0
Storage tray	2	1

We understand that further elements for the MFA course are being developed. There is a Computer Module, catalogue number 540.104 at £37.22 which is presently available, but which we have not evaluated.

We also understand, from Unilab, that all items can be purchased individually and that it is not necessary to buy in pack form as described above.

Concluding Remarks

The MFA course achieves what it sets out to do, i.e. to be an attractive, practically based, introductory course on microelectronics. Pupils are required to apply their knowledge practically in a problem solving way, and process is placed before content. The course will, we think, be absorbing, entertaining, motivating and taxing. School trials seem to be bearing this out.

Of the three basic modules, Decisions' and Counter are highly satisfactory, though as we have said, the sensors could have been on flying leads. The Memory Module is less satisfactory, there being points of confusion and limitations in its usage. The Memory Module does, however, put across many important concepts and adds considerably to the range of inventive applications to which the set of modules may be put. It would therefore be our recommendation that all three modules should be purchased in class set numbers with the addition of one or two of the extra modules as supplied with Pack A. Notwithstanding this advice, Pack B, which contains two modules, Decisions' and Counter, is itself the basis of an attractive and viable course. Prices of these packs are given above.

The two obvious places in the Scottish curriculum where the MFA course might be used are in Integrated Science or Technical Studies, in both cases with secondary years one or two. However the material is more widely applicable and is suitable at one end to a primary school looking for an off-the-peg electronics or technology course; at the other end to parts of the H grade physics digital electronics course; and to several stages in between.

Thus whilst a class pack is expensive, it could be used extensively throughout the curriculum. This factor should weigh in its favour if pondering purchase. We should also point out that the only expendables are the batteries.

We have given some thought into the ways by which the MFA course might develop. The course material, as it stands, is completely self-contained. Given the kit of boards and notes, a pupil need neither seek instruction from his or her teacher, nor leave the desk to fetch apparatus or components. Are we right in believing that one of the outcomes of this course, whether intentional or otherwise, is that pupils can complete a practically based course without, literally, getting off their backsides?

It would seem pertinent and justifiable therefore to let the course extend into practical work with practical difficulties; designing beyond the modules' capabilities, searching for components, looking up data books, coping with the perception difficulties of diagrams and circuits, manipulation of tools, controlling electro-mechanical gadgetry and so on. Here is a short list, certainly not an exhaustive one, of suggested extension material

- computer control,
- control of electro-mechanical devices,
- wiring with breadboard and integrated circuits,
- using more advanced tutor boards, e.g. Limrose Tutorkits 1 & 2, and
- use of a microprocessor training board.

In an earlier part of this Bulletin we have pointed out a limitation of basing a technology, or electronics, course entirely on a kit. We draw your attention to our "Opinion" column where these comments appear.

Acknowledgment

SSSERC would like to thank Hobsons Ltd. (Publishers of MFA) for their co-operation regarding the reproduction of diagrams.

*   *   *   *   *   *

Comments

At SSSERC's invitation, Dr. John Martin (Director of the Electronics Educational Development Unit, Salford University) of MEP has made the following comments on our evaluation report. [Dr. Martin was mainly responsible for the hardware design of MFA and chaired the working party whose remit concerned the educational aims of the MFA course.]

"...., I thought that the comments you made about the system were very fair..... With regard to the detailed points you made in your evaluation:

1. There is a difficult decision about how "self-contained" the materials should be. The sensors were mounted on boards because we have gone for a more self-contained approach. In the extensions to MFA which are being prepared a wide range of off-board sensors will be included.

2. When the materials were being developed we did include the facility for direct input into the memory module, e.g. from the temperature or light sensors (rather than the switches). Unfortunately this proved impracticable because we had to use CMOS Ram (in order to have the system battery powered) and the <u>only</u> CMOS Ram that we could find that was suitable in terms of size and cost has a particular feature. Data is latched into the memory on the edge of the write button. Therefore if one attempted data-logging (with the write button depressed) erroneous data would be entered (because it is <u>not</u> latched on the edge of the address lines); I do regret not having this facility available, it would have required considerable circuit elaboration to have provided it.

3. I wholeheartedly agree with your more general points about the "kit" based technology; it can reduce to puzzle solving. We are developing materials for extension and project work in CDT which will definitely involve getting off one's "bum"."

Abstract

Descriptions and construction details of three pieces of equipment presented in Standard Grade exemplars are given below.

Concrete beams

Two main difficulties are encountered here - firstly the construction of the moulds so that they release the beams cleanly, and secondly that of using suitable combinations of 'mix' and dimensions to give a beam which can be broken by a reasonable size of loading.

Concrete tends to adhere to many surfaces _ fortunately so or its use in the construction industry would be severely limited! Thus it tends to stick to the sides of moulds, and either the beams emerge with lumps missing from their faces or the mould edge becomes 'dirty'. This of course ensures that the next batch sticks very well to the mould! Several designs have been used in the Centre, but the most successful tried so far has been a mould constructed from melamine faced chipboard. A slight smear of vaseline further assists the clean removal of the beam. A mould, of the construction described here, has been used at least eight times and has remained clean.

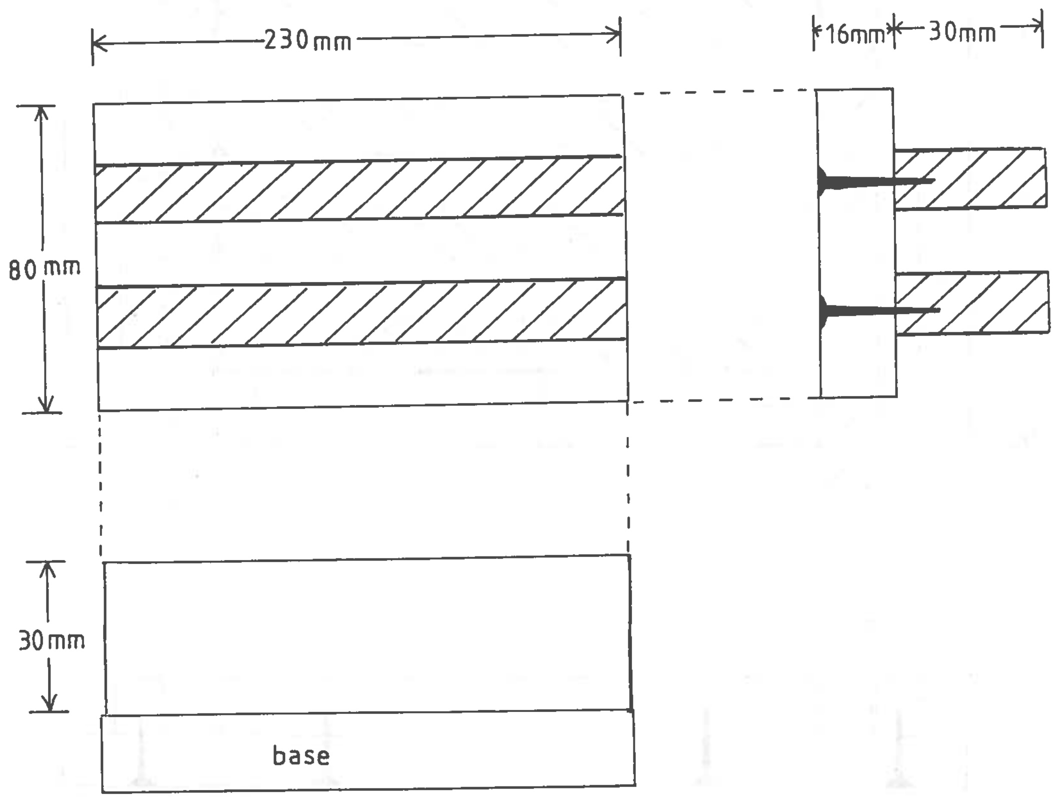

Fig.1

The strength of concrete is very variable, depending on several factors in addition to the composition of the mix, viz. the time the concrete is allowed to cure, how well it is mixed and how well it is tamped into the mould. Other factors include the temperature and also the age of the cement at time of use. We found that the same 'mix' made up in different ways gave beams of very different strengths. In fact it proved possible to produce a beam from a 'weak' mix which was unexpectedly stronger than one made from a 'stronger' mix. Thus to obtain fair comparisons all of these variables should be controlled as carefully as possible. It will probably not even be valid to compare two beams, made from cement out of the same bag, if they have been made at times more than a few weeks apart, despite having been cured for the same length of time. All of the beams for a particular class should ideally be

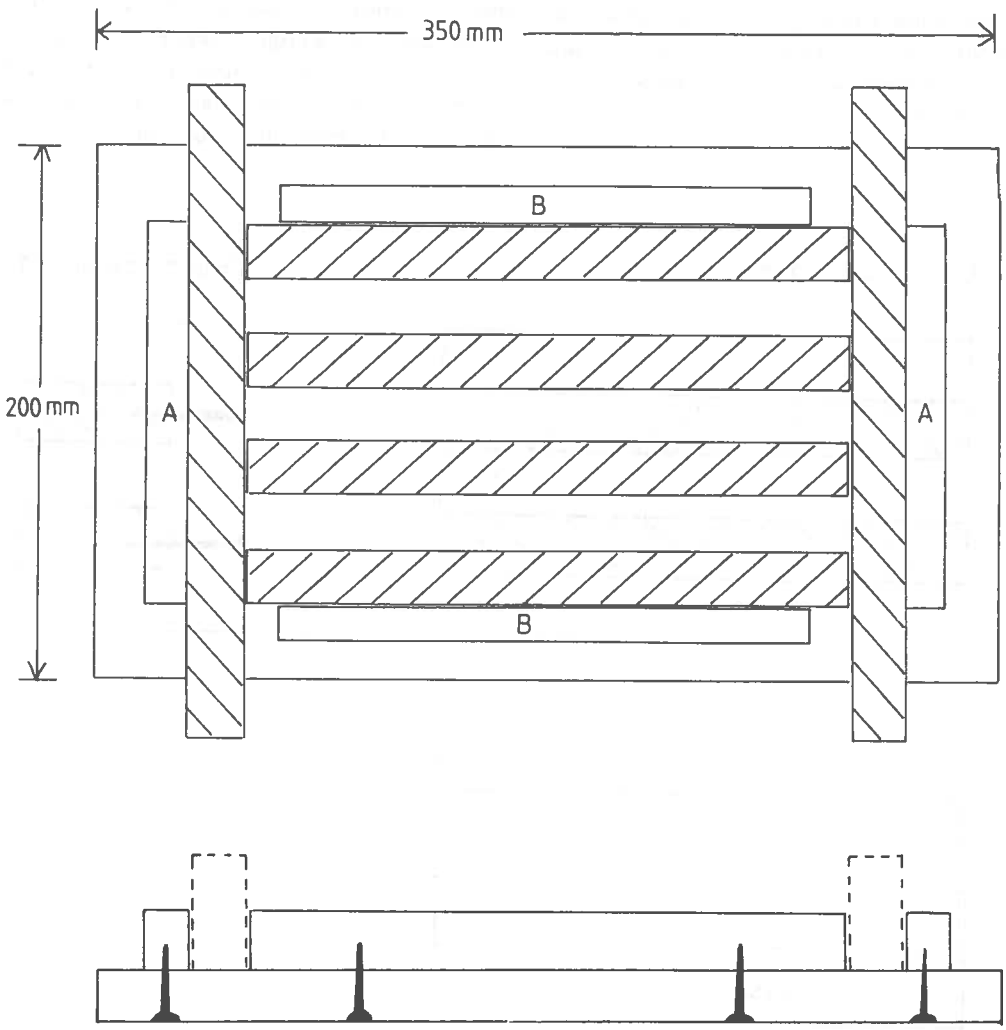

Fig.2

poured at the same occasion. Old samples of cement will not have much 'life' left in them and we would recommend the use of fresh cement.

In order to reduce the loading needed we used narrower, albeit shorter beams, and generally weaker mixtures than were recommended in the exemplars. The mixtures used in the Centre were in the proportions of 6:2:1 and 4:2:1 (sand/gravel/cement), and the beams measured 230 X 30 X 16 mm.

Examples of destructive loadings found are

6:2:1	3 kg
4:2:1	6 kg

The construction details are given below.

(a) The **mould** itself is first made as in Fig.1. The number of beams produced per batch could be increased by scaling up the width and using extra melamine dividers.

The screws used should be brass, No.6, 1½". They should be countersunk and left slightly loose so that the divider blocks can be wobbled to release the beams. Four lengths of double faced melamine 230 X 45 X 16 mm should be cut to make the sides and ends.

(b) The **base** is fitted with whitewood supports as follows:

Place the mould on the base as shown in Fig.2 and press the mould sides and ends against it. In turn push the softwood supports (marked A and B in Fig.2) against these and pin to the base.

Now fix the supports with screws and check that that all the parts can be easily fitted and removed. Finally paint all exposed edges with two coats of aluminium paint.

Materials

whitewood, 25 X 25 mm, 1 m length
Contiboard, melamine, double-faced, 230 X 15 mm, 1 m length
brass screws, No.6, 1½", c/s, qty. 6
brass screws, No.8, 1", c/s, qty. 8

Cutting list

part	size (mm)	quantity
contiboard base	200 X 350 X 15	1
mould base	230 X 80 X 15	1
mould sides	230 X 45 X 15	4
mould dividers	230 X 30 X 15	2
whitewood supports	230 X 25 X 25	2
whitewood supports	123 X 25 X 25	2

A threadstretcher (or the simple grommet.)

Outwardly there seems to be little startling here. One of the problems common to all rigs for stretching threads or metal wires is the mode of anchorage. Often the very device used, e.g. a screw clip, weakens the wire at this point and that is where the break frequently occurs. Chucks are useful here but have the disadvantage that it is difficult to adjust the length once the thread has been clamped. Guitar keys are another possibility, but an expensive one.

An excellent anchorage point which does not damage the thread can be made by gently squashing the grommet by a washer and screw. The thread is first attached to the small ring which also acts as a pointer. The free end is then drawn through the "fold" of the grommet and when the pointer indicates a length of 50 cm, or any other chosen standard length, the loose end is secured by wrapping it several times inside the fold of the grommet (Fig.3).

Another simple idea used in this device is to have the linen thread pass through a small eyelet before running over the pulley. This acts as a stop should the test thread break.

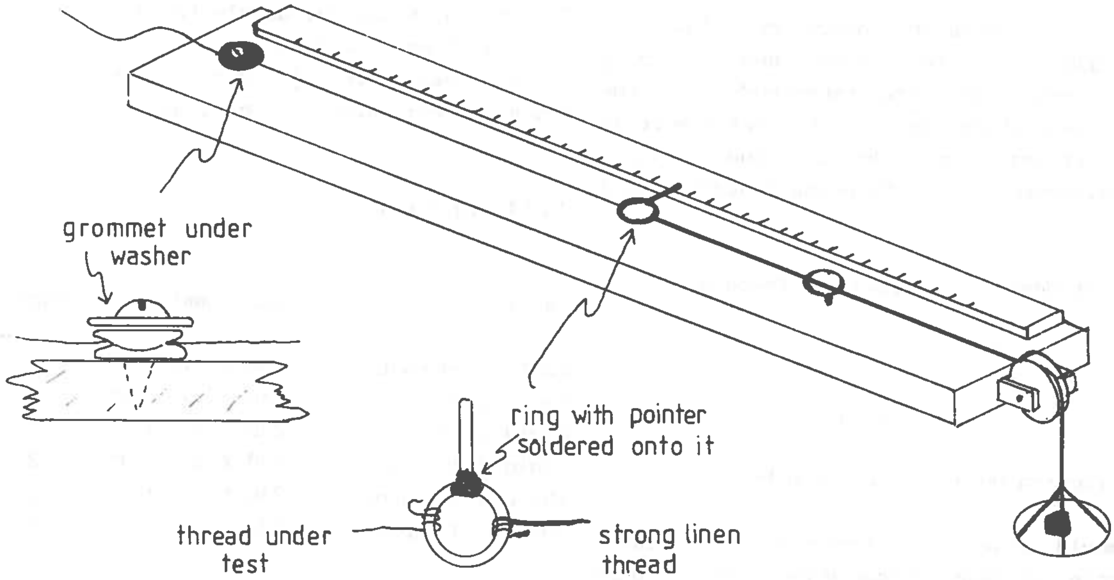
grommet under washer
ring with pointer soldered onto it
thread under test
strong linen thread

Fig.3

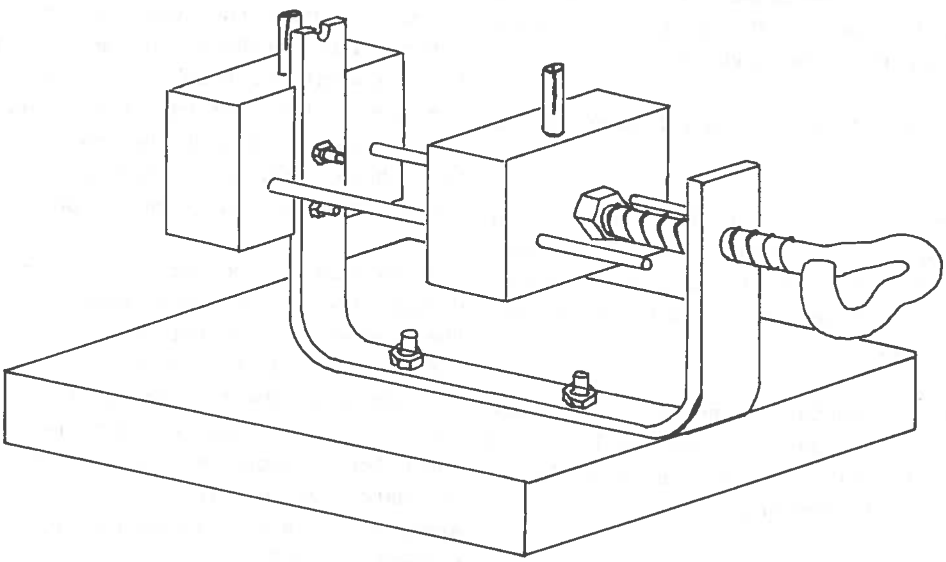

Fig.4

Stretching metal wires

An alternative to the device shown in the exemplar materials is described here. It makes use of the readily available fret clamp which, when mounted on a base, forms the backbone of the rig.

The wire is anchored by wrapping it several times round a pin taken from an obsolete 5 amp plug. The wire is then fed through the split in the middle. The rounded edge of the pin will get over the problems of weakening the wire at the point of connection. The moving block will have a tendency to rotate and two metal guides fastened into the fixed block prevent this. (Fig.4).

As in all other cases where wires or threads are being stretched eye protection should be worn.

For construction details please refer to the following article in "In the Workshop".

IN THE WORKSHOP

Rig for stretching metal wires

The dimensions given are those used by us for a 4" clamp. These are not critical but would obviously have to be altered if a different size of clamp were used.

The **clamp** first requires some modification before mounting it on the base. The numbers below correspond with Fig.1.

(i) Two holes (1/4") are drilled in the spine of the clamp (1) to take 1/4" Whitworth machine screws 1½" long for attaching the clamp to the base.

(ii) To enable the fastening of the fixed wooden block with two small bolts (6BA), two small holes are drilled centrally in the top jaw (2). The position of these holes is not critical but should be towards the bottom of the block.

(iii) A slot or vee is cut out of the top jaw(3) to allow the test wire to pass over it.

(iv) The clamping button at the end of the lead-screw (4) is sawn off and a small hole (say 2 mm) is drilled across the diameter of the lead-screw near the sawn end. A small split pin or bolt in this hole can hold a washer (3/8" diam.) which will bear against and drag the moving block away from the fixed block.

Before fastening the two wooden **blocks** (42 X 47 X 19 mm in our case) to the clamp they should be modified as follows:

(i) Check out a centrally placed shallow slot (e.g. 1 - 2 mm) equal in width to that of the clamp. This enables the fixed block to sit astride the top jaw of the clamp (Fig.1b-5).

(ii) In the moving block drill a centrally placed hole slightly larger than the diameter of the lead-screw on which the block can slide (Fig.1d).

(iii) Clamp the blocks together and drill out two guideline holes on both sides of the hole drilled in (ii). Separate the blocks and drill these out in the fixed block to provide a driving fit for the two metal guides (two 110 mm lengths of 1/8" silver steel rod in our case.) In the moving block these should be drilled out a little more to provide a sliding fit for the metal rods.

(iv) In the top of each block drill a hole to give a driving fit for the slotted 5 amp pins.

(v) Fit the moving block to the lead-screw and secure it with the washer and split pin. The nut on the 'closed' side can now be locked so that it is approximately 1 mm away from the moving block. A dab of Loctite glue or a second locking nut will do this.

(vi) The correct position of the fixed block can now be found by offering it up to the top jaw of the clamp and slotting the guide rods into the moving block. With the guide rods parallel to the lead-screw, mark on the fixed

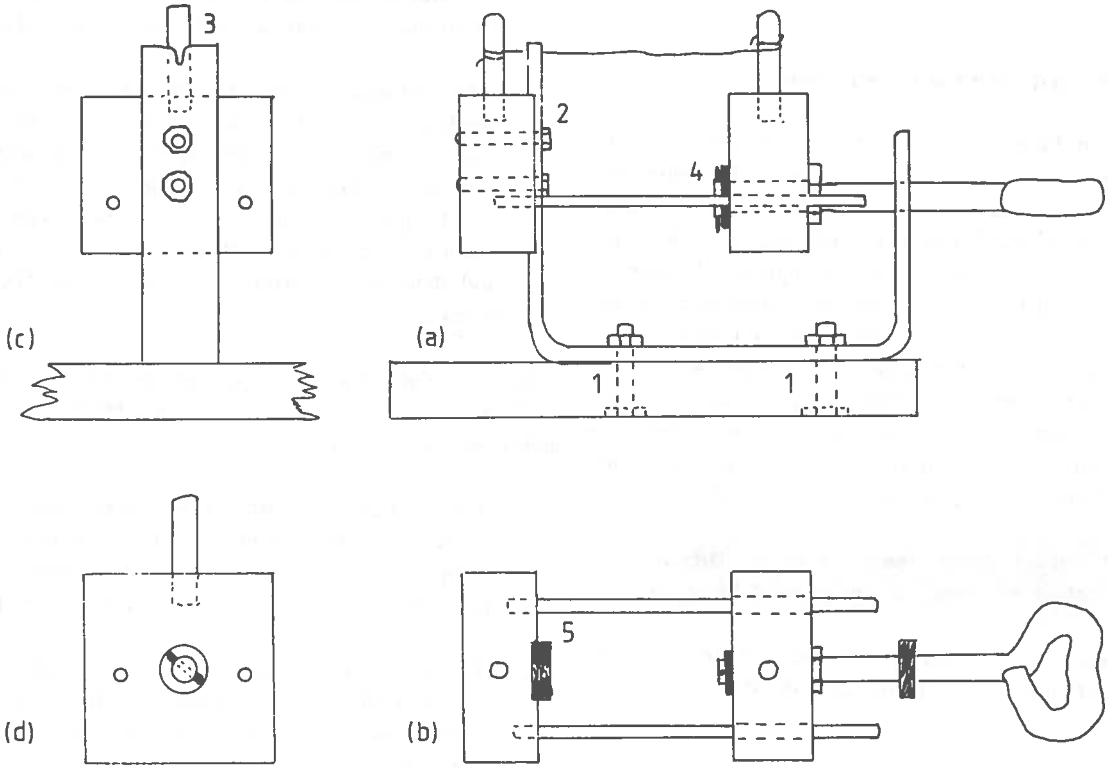

Fig.1

block the position of the two small holes already drilled in the clamp (see 2 above). Drill out these holes in the block, replace the fixed block with its guide rods and bolt it to the clamp with two 6BA bolts.

All of the materials needed are available from most ironmongers:

	quantity
fret clamp, 4"	1
obsolete 5 amp pin with slot, or alternative	2
washer, 3/8" diam.	1
2BA bolt or small split pin	1
6BA bolt and nut	2
1/4" machine screws, 1½", & nuts	2
1/8" rod, preferably silver steel (approx 12")	1 length
3/4" Whitworth nut	1 or 2

ASE ANNUAL MEETING 1985

This year's Annual Meeting was held at the University of Keele.

Some personal impressions

Beware the siren voice of technology. That was the warning given to members of the Association a few years back by the then president in his presidential address. But as is the way of life counsel supplied by the old to the young often goes unheeded. This warning reminds me of advice given to a former colleage on his going up to university, "take care to keep out of bad company". His story unfolds so predictably that I need hardly tell it, but sketching in just a few details, in his first year he wondered what it was that his mother, did you guess that part, had warned him about; in his second year he actively sought out the bad company she had warned him of; and in his third year he realised that he was the bad company he had been warned to avoid.

Well at Keele this year there were lectures, discussion groups, seminars and talks on one aspect or another of technology; electronics, microelectronics, biotechnology, bioengineering, primary technology, science in industry, and so on. Out of the twenty seminars, no less than ten were directly on, or related to, technology education. Outwith the lecture rooms one came across LEGO and Fischertechnic gadgets under control at stands of most of the main equipment exhibitors. There was, too, a place for unbelievers, the local version of the Flat Earth Society. They had their meeting, on the unofficial programme. "Ban Electronics from Physics". If this gathering of the science teaching profession is at all indicative, and with over 3000 of us it was a sizeable gathering, it would seem that most of us have chosen to eschew the advice of our past president. Technology in education is a fashion that is booming; south of the border that is.

To give an impression of the thinking which these meetings exposed, the following extracts, some copied literally, others rewritten, are taken from the synopses in the programme.

Traditionally, technology in schools has been built on a craft foundation instead of being given the science base which is so essential.

Our educational attitude undermines the importance of manufacture in the creation of the nation's wealth.

There is a view that all school pupils should receive, as part of their general education, a balanced awareness of biotechnology?

Does responsibility for technology awareness rest with the science teacher?
Ways should be examined in which school science and technology can be related to works experience in a meaningful fashion.

Ways and means have to be devised of bringing into effect adequate in-service training programmes.

The role of the science teacher in science/CDT partnership should be examined.

Many ... believe ... there is a growing need to encourage children to use technology of various forms in the problem solving situation often encountered in primary science. This is evident in a variety of applications from "rubber band technology" to the utilising of quite advanced microelectronics.

How can schools learn from the experience of TVEI schemes?

If you think that LEGO is just a child's toy you are wrong!

What resources are needed to bring school science into closer contact with technology and the world outside the classroom?

In spite of previous efforts to build bridges, science and craft teaching too often remain stubbornly isolated from each other. What are the constraints that make cooperation so problematic?

There is now a general consensus that all pupils should know something of the nature, capabilities and limitations of microelectronics technology. But the role of the science teacher in regarding the techniques of electronics as the preserve of science education is questioned. It may be that the preserve of science teachers should be restricted to, say, the process of information capture, etc.

It was encouraging to find biotechnology as the subject of a major, three hour symposium. However despite all that talk, and despite some mention of lemonade bottle fermenters, the emphasis was definitely on "awareness". Echoes of early educational strategies for microelectronics? Notwithstanding a few practical demonstrations in the exhibitions, there was little I would call biotechnology. As a mere physicist my judgement on this matter is intuitive, rather than expert.

By my criterion biotechnology is the application of biological principles, and a multi-disciplinary mix of techniques, to the solution of practical problems. One of my own ingenuous impressions is of a control process comprising several, or all, of the following elements, vats or vessels, pipework, pumps, valves, sensors, a heat source, an organism with a voracious reproductive habit and a suitable supply of nourishment. It was therefore with some disappointment, on prying into one so called biotechnology course, to find it was on the use of preservatives, that group of chemicals, euphemistically named, which in fact kill off all and sundry in order to preserve inert chemical products and foodstuffs.

So, my kind of biotechnology where are you? My biology colleague tells me that my definition of biotechnolgy has already been dubbed (snubbed?) as "technobiology" by the purer souls. Are we going to have the biologists now occupying the same muddy trenches as those manned by the "ban electronics from physics" brigade?

To finish, two major projects, both covering that shifting ground between science and technology, were launched at the Meeting. Here are the details.

Telecommunications in Practice

This joint ASE and British Telecom project has resulted in the publication of a lengthy resource book which largely deals with topics not covered elsewhere in the school technical press. These topics are mainly physics and electronics, but with some chemistry and mathematics also. Areas covered include

satellite communications

microelectronics and information technology

modelling a telephone exchange

pulse code modulation

terrestrial microwave systems

optical fibres

The book costs £5.00 and is available from the ASE.

Experimenting with Industry

The project is organised jointly by the ASE and the Standing Conference on School Science and Technology. It is resulting in a series of short specialized publications on science practicals which are industry related. The first four titles have already been published and are

Electrical testing

Optical fibres in school physics

Industrial use of micro-organisms

Sugar challenge

Approximately ten further titles are due to be published by Easter. If you wish information on further titles, or wish to order from the four already published, please contact the ASE.

S.S.S.E.R.C.
BULLETIN 144

CONTENTS

FEBRUARY, 1985