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SCOTTISH SCHOOLS SCIENCE EQUIPMENT RESEARCH CENTRE

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Video in Science
Interface update

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Newcastle Science and Technology Education Centre (NESTEC), Kielder House, Coach Lane Campus, Newcastle Polytechnic, Newcastle upon Tyne NE7 7XA Tel. 091 266 3409.

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(**continued** back inside cover)

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INTRODUCTION

Editorial

Errata - grovel, grovel

Given our obsession with Murphy and his laws, readers will understand why SSSERC staff each grab a copy of the 'Bulletin' before the printer's van has pulled away from the Broughton Street kerb. No, its not narcissism. Caffeinated masochists are they, the lot of them. They meet up, over tea-break, for group therapy and self-flagellation.

This activity is part of our quest for printed perfection. It also furthers ongoing research into tired old jokes all facets of Murphy, his law and variants. The seemingly pointless, post-publication proof reading is part of our investigation into that Murphy variant which states:

"Errors invisible to as many as three readers in proof, will leap off the page when the printer makes delivery".

We have recently formulated (okay, pinched) yet another variant. This is part of the MacPherson sub-set. It states simply that:

"Murphy was an optimist"

Like the 18th century aristo, I should never have done it, bared my neck that is. All that "Opinion" twaddle about illiterate sloppiness re-awoke the Centre gremlins. We apologise for the shot in the foot, the missing "you" in that same "Opinion" on page 3 and for the superscript number missing from page 15. As witnessed by the "Erratum" notice on the cover of No.153, with the incorrect caption and labelling in Fig.1, page 9 we beat Murphy and the printer to the punch, but only just.

We promise to do better in future. There I go again with that neck of mine.

Delays - fawn,fawn

Bulletin 153 carried, in addition to errors, an offer of Surplus Equipment. Hopeful customers may well be puzzled by an apparently unnecessary delay between the time they send their wee postcard ballot entries and our congratulatory replies. We can only say - quoting some of the great mail order scoundrels down the ages - "This is due to circumstances outwith our control".

We are finding that the gap between our despatch of bulk deliveries of bulletins and their eventual arrival in the schools seems to be widening. We are having to wait longer before drawing any ballot to ensure that some Regions' or Divisions' schools have received their copies of the "Bulletin". Ironically, it is often some of the more remote schools who contact us first but then many of them still have their copies directly mailed.

If you are suffering unacceptable delays between publication and delivery dates please let us know. However you might do better to ask "Sh!..you know who" in EA or school for a lowering of any obstacles lying nearer your end of the carrier snail system.

Domestic & other matters

Festive season closure

Please note that the Centre will close at the end of business on Wednesday, 24th December 1986 and will re-open on the morning of Monday 5th January, 1987.

ASE Annual Meeting, 1987

The ASE parent body meeting will be held in University College, Cardiff from the 2nd to the 5th of January, 1987. As always, ASE has arranged a full and varied programme for what must be the largest specialist science education meeting in Europe.

"Viewing highly recommended", as the estate agents are wont to say.

RESOURCE NEWS

CLEAPSE guides

We have recently received the following publications from our sister organisation, CLEAPSE School Science Service:

L36 - "Simple Electrical Connections" July 1986

L59c - "Regulated LV Power Supplies" revised July 1986.

L107 - "Newtonmeters" revised July,1986.

L169 - "Environmental Equipment", reviseo July, 1986. (Simple equipment and procedures suitable for use P7 to S3, [our description]).

Copies of these guides are available on a one month loan, on application to the Director of SSSERC.

Environmental Education

Coincidences may indeed be curious in the sense that they can make you inquisitive. They make you wonder whether there may be something in this parapyschology business. No sooner had we got the last "Bulletin" back from the presses; with its pieces on the Earthlife Association, CAT and the International Centre for Conservation Education; when arriveth a bundle of reading matter from the World Wildlife Fund Education Department.

As well as a list of teaching resources, wallcharts etc. the material included information on a major eduational initiative from the World Wildlife Fund, Oxfam and FoE. A three year project, entitled "Global Impact", "aims to introduce fundamental changes in the curricula of UK schools so that children in the 1990's can understand and take action on important environmental issues". Heady, but worthy, stuff. If you want to know more then contact project staff in the World Studies Teacher Training Centre, at their York address on the inside cover of this bulletin.

Surplus equipment and components - other sources

Other Centres, notably some SATROs (Science and Technology Regional Organisations) offer a surplus or component supply service. Schools in the West of Scotland for example can approach the Science and Technology Forum at Strathclyde University. We understand that a similar re-cycling scheme may be set up in the new North of Scotland SATRO in Aberdeen. However for long established surplus schemes, as an alternative source to SSSERC, it is necessary to look south of the border.

The Surplus Buying Agency for Schools (SBA) is still going strong. Their latest list, No.52, October 1986, whilst no longer than ours, does have many interesting items which we do not currently offer. In addition to electrical and electronic components the SBA stocklist shows tools, magnetic materials, miscellaneous items such as masking tape, clip boards and insulating tape. Of interest for primary, technology and CDT project work is a range of small propellors, and wooden and plastic wheels.

Another sassenach SATRO not averse to cross-border orders is NESTEC, the Newcastle Science and Technology Education Centre. Nowadays best known for their amazingly low-priced computer buggy, they also supply a surprisingly wide range of components and materials again including mechanical devices. The majority of the NESTEC catalogue items are very keenly priced. There may be cheaper sources for a few of the instruments and like equipment. Stock lists are available from the address on the inside cover of this bulletin.

* * * * *

NO COMMENT

Seen recently, on a business card:

SYRINX

Innovations Limited

Richard Brown,
Empiricist.

In this section of Bulletin 151 we alluded to "more useful little publications" from the Health and Safety Commission, Education Service Advisory Committee. Two pocket cards have now been produced. As this bulletin goes to press these safety cards should be being 'press-released' as any Philistine might say. That means they should be available from HSE offices and the HSE Information Point by the time you receive this. The cards are entitled:

> "Do you work with chemicals and other materials in educational establishments?", and
>
> "Guidance to cleaning staff in educational establishments" [has a section aimed at those who clean laboratories].

Both publications are of small format, carefully worded with a "do" and "do not" layout and are deliberately non-technical being aimed at a wide and non-specialist group. The card giving advice to cleaning staff is particularly welcome. They have been somewhat neglected for certain types of guidance, yet the accident statistics show them as being, overall, one of the groups in schools at most risk of accident.

*   *   *   *   *   *   *   *   *

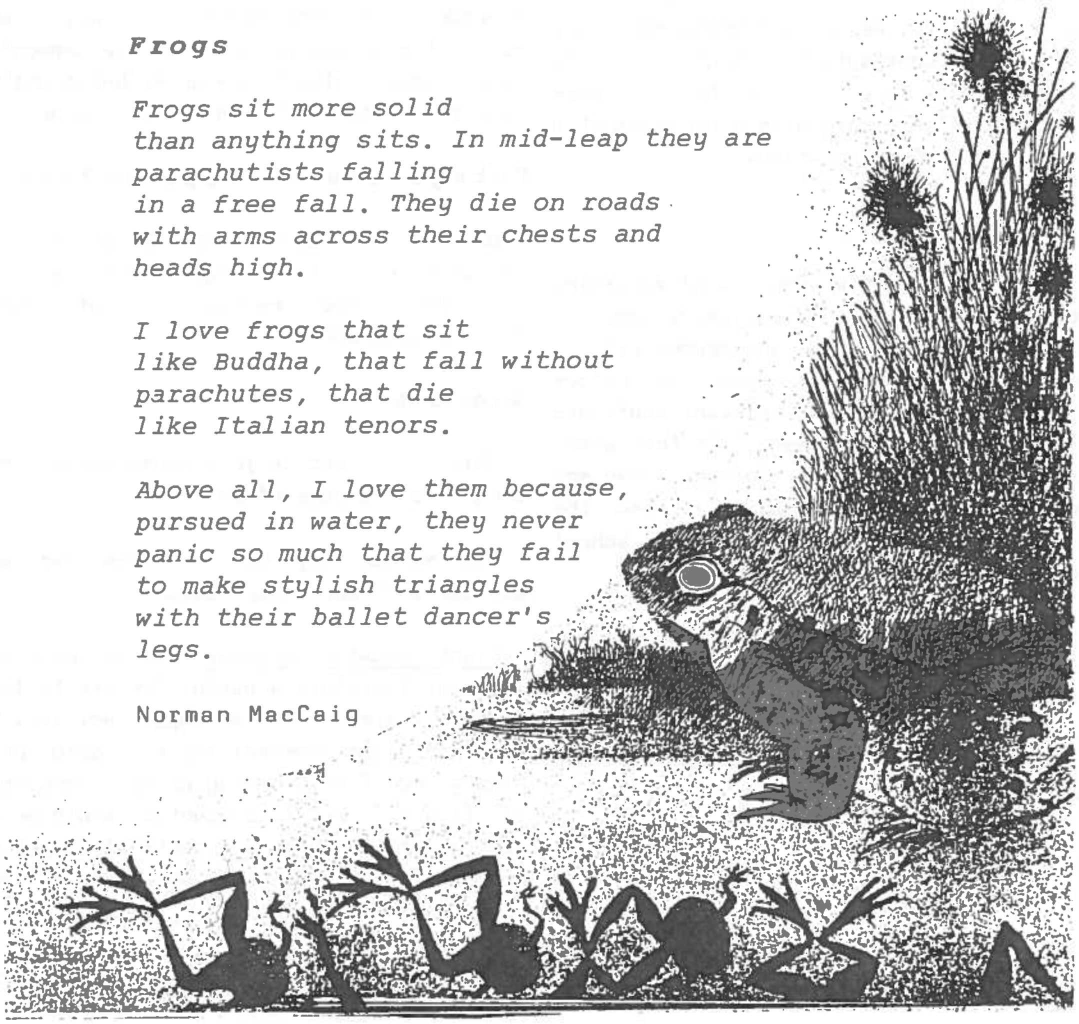
Frogs

Frogs sit more solid
than anything sits. In mid-leap they are
parachutists falling
in a free fall. They die on roads
with arms across their chests and
heads high.

I love frogs that sit
like Buddha, that fall without
parachutes, that die
like Italian tenors.

Above all, I love them because,
pursued in water, they never
panic so much that they fail
to make stylish triangles
with their ballet dancer's
legs.

Norman MacCaig



Video Equipment in Science Teaching

An overview

Abstract

Science teachers are encouraged to seek involvement in the selection of school video equipment. Features which make such equipment more useful in science are outlined. An account is given of one teacher's experience and experimentation with video microscopy.

Introduction

Audio-visual equipment, when used merely as educational technology, is not part of the SSSERC remit. It does fall within that remit when used for observation and measurement in science and technology education. We are not being precious. The distinction is important. It should be made and too often is not. A parallel is the difference between experimental simulation on a microcomputer and computer aided experimentation.

Purchasing patterns

Closed circuit television and visual recording (all truncated now to "video") equipment may be purchased for a school without any recognition of the requirements of science and technology courses. That may be because relevant staff are not consulted or are not aware of the wider possibilities of video in their teaching. They may not know those features which extend the usefulness of cameras and recorders for school scientific and technological activity.

It is most unlikely at present that individual science departments could afford video equipment for their sole or major use. We know of some science departments, recipients of TVEI largesse, who have such access to video equipment. This may become commoner as that initiative is extended. For now, all many departments can do is to seek to influence purchasing decisions made on a whole school basis.

Possible applications and useful features

SSSERC has done some preliminary work on this topic. We give below an initial outline of possible practical applications in science related areas. We can also suggest some specific features of video equipment which would extend its usefulness in science. These features include:

time-lapse,
slow motion,
single frame replay,
on screen time display,
keypad character generator for captioning,
microscope adaptor,
and microcomputer interface.

Particular cameras, VCRs (video cassette recorders) and combined portable units which lie within the school price range now commonly have at least some of those features. Unfortunately it is rare as yet to find them all in a single system.

Categories of application

We can see three overlapping categories of work in science and technology. These are in kinetics, and the video equivalents of macro- and micro-photography.

Kinetics

This is kinetics in a broad sense, that of the study and analysis of motion.

The motion may be too slow for acceptable periods of direct observation.

Plant growth movement (taxis) provides a good example. Therefore a useful feature to look for in a video system is a **time-lapse** facility. Of course recordings are commercially available of growing plants and of the opening or sun-tracking movement of flowers. D-i-y production would be even more useful for the direct practical experience, in projects; and for short sequences edited in with other material.

Time lapse, of a sort, is available on some VCRs within the school price range. It is afforded by systems with security applications features. Their commoner usage is for surviellance but they can be used in studies of plant growth and other slow events. The time lapse effect is achieved because images are recorded at lower rates than the usual 25 frames per second but are played back at that rate. In security work, where systems are operating continuously and chiefly as aids to identification, this is a device to save on video-tape.

Obversely, the motion may too rapid for analysis by human eye and brain. Here the useful features to look for are **slow-motion, single-frame** and **freeze-frame**.

In cinematography slow motion is achieved by increasing the speed of the film through the shutter gate and subsequently projecting at the normal rate. Video cameras and recorders use a different mechanism to capture and display an image. Here each 'frame' is built up line by line. Not suprisingly inexpensive cameras are limited in the number of images per second which they can capture and record. The slow motion effect is given by slowing down the rate of replay - another difference from cinematography. Slow motion, frame-by-frame and freeze frame are thus but variants of a reduced replay rate.

A slow-motion video facility which can cope with rapid transients has yet to appear at educational prices. The limit is set by the scanning or frame rate. Typically on small VCRs for domestic use this is 25 frames per second. Recordings may be played back at as little as one twenty fifth of that rate i.e. 1 frame per second. However, should the rate of change under observation significantly exceed the scanning rate, there will be unaccept -able blurring on individual frames. Equipment to professional or broadcast standards would be needed to study rapid transients. Such equipment is an order of magnitude more expensive than that designed for amateur or educational use. For less demanding motion analysis some useful work is feasible with relatively inexpensive equipment.

A typical application is in a study of projectile motion. For example we carried out some trials where we studied the motion of a tennis ball against a white backboard of 1 x 1 m with a 10 cm, black line grid. The camera was a Panasonic A1, recorder an AG 6200 from the same manufacturer. The display was provided by a green screen monitor pinched from one of our microcomputer systems. We also found that a tripod was required to reduce camera shake.

The ball was bounced on the bench and its track recorded against the grid. When the recording was played back frame by frame it was possible to note the position of the ball against the grid and to relate this to time. The Panasonic A1 system has a stopwatch facility which superimposes the time on one corner of the screen. The major limitation of such a set-up is the number of frames per second taken by the camera. We found that blurring of the image became significant at speeds above about 3 ms^{-1}.

The same speed limitation applies in another major area of interest. This is the study of human movement. The science of sport is assuming more curricular importance. A paper on the physics of sport has already been published by the Education for the Industrial Society Project [1]. Sport science is a topic in the draft Standard Grade Physics and Biology syllabuses. Parts of some school courses in physical education now also have scientific content. Clearly facilities to slow down or stop images of human movement should be very useful. Both scientific and aesthetic aspects of animal movement make this a potentially rewarding area. The latter aspect provided us with the excuse to deny the 'two cultures' lobby and to reproduce, on page 3 , the poem by Norman MacCaig.

In our trials with the Panasonic equipment we found that we could analyse actions such as vertical jumping from rest. There the speed was not high enough to cause serious blurring. However the system clearly was incapable of resolving high speed movement. A limit of 3 ms^{-1} is equivalent to about 7 mph. Jogging should be resolved but sprinting would not.

Unfortunately the limitations caused by blurring still apply when analysis of an action is attempted by examining a single, still or frozen frame. Additional complication arises because of the ways in which a still frame facility may operate.

For near perfect still frames, the video playback mechanism must have 4 replay heads. Ordinary, domestic VCR's have only 2 heads in total or 2 ordinary heads and 2 long play heads. Such mechanisms will not produce quality still pictures. A true 4 head device is needed. (See figure 1). One source of suitable machines, which we have seen in use, is given at the end of the article.

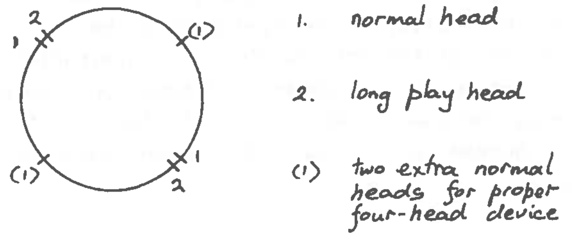


Fig.1

Macro-video

This is the equivalent of macro-photography (photography at low magnification) where an object or detail already visible to the naked eye is further enlarged. This may be to allow more detail to be seen or the same amount of detail to be evident to a group of observers.

Obvious applications are in teacher demonstrations in order to show small features on components or parts of apparatus. It is the high-tech equivalent of the epidiascope and o.h.p. without some of the limitations. Modern lightweight cameras can focus on objects 20 mm distant from the front of the lens. For example labels on integrated circuits may be clearly legible to a large audience. Apparatus used for special demonstration may need only to be pupil scale.

In our own work we have found video useful for clarifying small points of equipment detail. For example in one lecture we were able to demonstrate, live, an application of the piezo properties of a new material. The audience occupied a large lecture theatre but all were able to see what was happening in an area of bench less than 150 mm square. (The camera was on loan, we hasten to add. Would that we could afford to buy one!).

One disadvantage we experienced was that colour changes in some chemistry demonstrations were not shown as clearly as on an o.h.p.

A useful additional facility is an alphanumeric keypad or character generator. This may be used to overlay a title or label on the screen image. Such a facility also enhances applications in the next category, that of micro-video.

Micro-video

Given sensible usage video-microscopy is a powerful educational technique. Any school purchasing new camera equipment would be ill-advised in buying a model unable to take a **microscope adaptor tube** or **'C-mount'**. Bulletin 140 indicated some of the features of good and bad practice in school video-microscopy. Usually to be avoided are unimaginative, straight micro-projection applications with prepared slides. However given that the school has a suitable basic set-up then the small extra expense to adapt for microscope work is readily justified by a range of worthwhile activities.

A practitioner's account

Some of the more exciting work we have seen in video has been that of Philip Donnelly at TVEI Inverclyde. For two years part of his remit has been to develop the use of school video equipment across the curriculum. A major aim of the work was to assist teachers to appreciate the valuable contribution which video can make to everyday teaching, in distinction to the more common perception of a means of making 'films' on particular topics. The work has had positive results in subjects as diverse as Art, English, Modern Languages, PE and the three sciences. One area which has generated great interest is the use of video microscopy in biology teaching.

We persuaded Phil to write an account of his work as it stood at the end of last session. An edited version of that account follows. Credit for the bright ideas and the photography must go to Philip. Blame for any mistakes rests with us.

Basic arrangements -transmitted light

Video microscopy may sound esoteric but in reality it is surprisingly simple. It involves no more than fitting the camera to a microscope eyepiece tube and viewing the result on a monitor. With modern, compact and lightweight colour cameras this is as easy as it sounds. The GX-N7E from JVC shown in Figure 2 is one example of such cameras. Here the zoom lens has been removed and a lens mount adaptor fitted. That in turn has been married to a microscope adaptor of the type normally used to fit a 35 mm camera to the eyepiece tube. Such still camera adaptors are widely available from either photographic dealers or the microscope supplier. The whole process takes about five minutes and the only tool needed is a screwdriver.

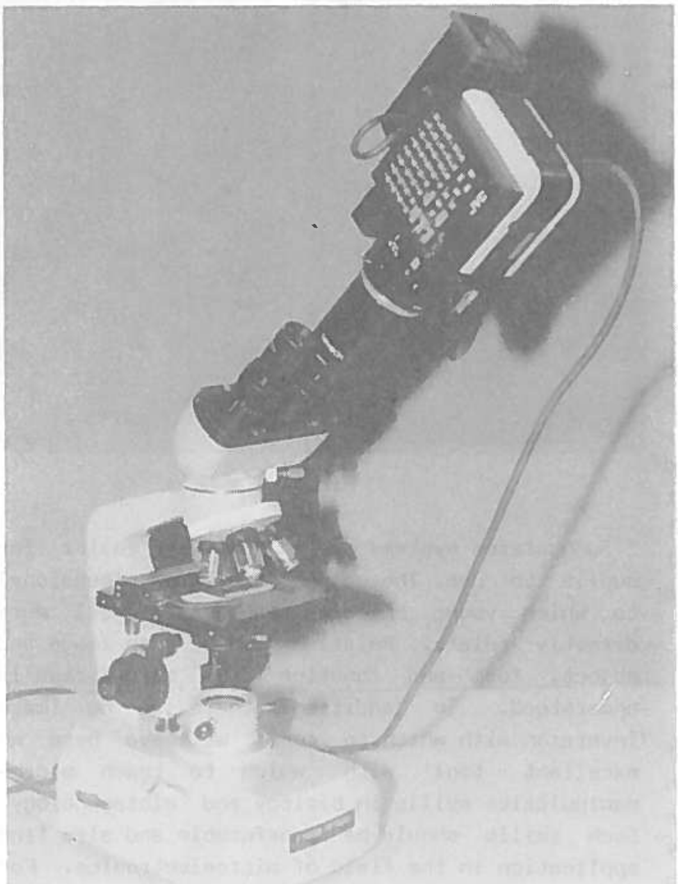


Fig.2

Microscopes and lighting

The microscope in Figs. 2 & 3 is a teacher demonstration instrument, a Kyowa model. However, all the initial development work was done with an Olympus model borrowed from a school. Modern cameras designed for domestic use will operate in relatively low light. The built in illuminators on many school demonstration instruments will provide all the illumination necessary. With microscopes lacking such sub-stage illuminators, bench lamps with 100 W bulbs (and brass lampholders to withstand the heat) can be used. This should be adequate if there is a sub-stage condenser to focus the source at the specimen plane on the microscope slide. Better still would be a lamp with its own condenser lens. This would allow Kohler illumination, where an image of the lamp filament is focussed on the microscope iris diaphragm.

Display techniques

Direct

There are a number of options in displaying the image. The simplest system involves a camera powered by its own a.c. power source with the video signal being sent directly to a monitor.

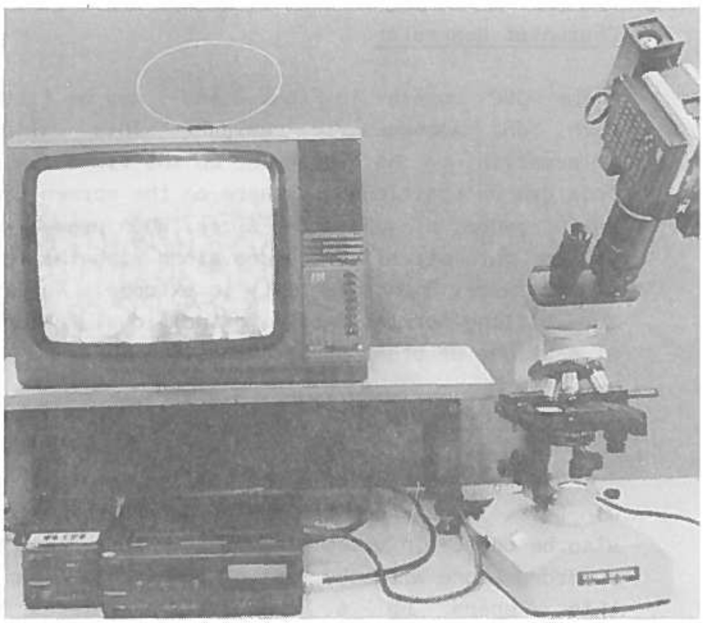


Fig.3

We used the commonly held ITT RL2301, 14" colour monitor. This arrangement allows direct viewing of the colour image as normally seen at the microscope eyepiece.

Via a mains video cassette recorder (VCR)

The "video out" on the camera power supply unit may be connected to a video recorder. Figure 3 shows such an arrangement. The advantage this confers is a facility to archive visual material at the same time as it is being relayed to the monitor screen via the recorder RF ('aerial') cable.

Via a portable VCR

Possibly the best system is one using a mains/battery, portable recorder. One suitable model we have used at Inverclyde is National Panasonic's NV-180B. This is very compact and because the camera is powered directly from the recorder a separate power supply is not required. Another reason for choosing such a system is its versatility. With the camera and its normal lens system reunited for non-microscopic use, camera and recorder provide a complete lightweight system for field studies or general use indoors.

Other useful facilities

Character generator

The JVC camera in Figs. 2 and 3 may be fitted with an alphanumeric keypad. This allows information to be over-typed on the video image. This can be positioned anywhere on the screen and in a range of character sizes. When present it will be automatically recorded along with the rest of the image. Such a facility is extremely useful for titling or for labelling individual features of sections or other preparations.

Time displays

These were mentioned in the earlier context of kinetics. Stop watch and day or date displays can also be useful in video microscopy. They can be recorded along with the rest of the image. Clearly this opens up a number of interesting possibilities in practical microscopy on sequential changes in histology, anatomy and morphology.

Video and stereomicroscopy

All of the initial trialling was done with transmitted light on microscopes borrowed from a school biology department. Recently a Kyowa zoom stereomicroscope with a "one inch photo tube" has been obtained (see Fig.4). This has allowed the display of images of three dimensional objects at relatively low magnification. For example it was possible to dissect out crocus anthers on the microscope stage.

Without exaggeration, the results were quite stunning with individual pollen grains clearly visible and spilling out of the pollen sacs. [We can vouch for that, SSSERC Ed.].

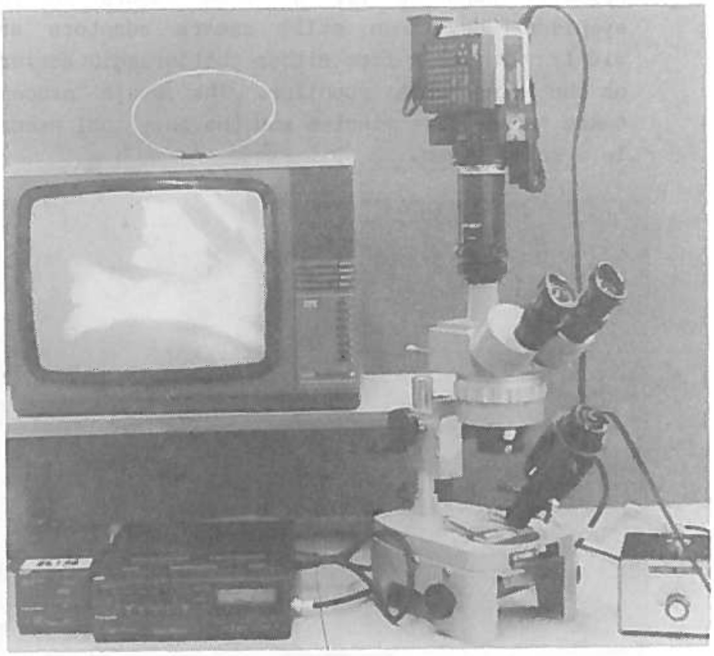


Fig.4

Such stereo systems are in some ways easier for pupils to use. The objects are three dimensional to which young children especially will more directly relate. Relationships between image and object, form and function are more readily understood. In addition there is no image inversion with which to cope. We have here an excellent tool with which to teach micro-manipulative skills in biology and biotechnology. Such skills should be transferable and also find application in the field of microelectronics. For their aesthetic value alone some images are well worth the trouble.

Video-microscopy and interfacing

The video microscope system can be interfaced to microcomputers such as the 'Beeb'. Image digitisers are available with reasonably friendly menu-driven software. Relatively expensive at present, but like everything else in this game, getting cheaper. Live or recorded video images can be digitised (horrible word) and stored on floppy disc. Once so transformed the image can be dumped to a printer. Trials have produced acceptable black and white printouts of plant sections on a standard Epson dot-matrix printer. Colour is also possible if you have access to a suitable colour printer using ink-jet or one of the newer alternative mechanisms (also getting cheaper). Quality of print-out does depend in both cases on the degree of contrast in the original image. In some cases excellent video-micrographs are possible. With other, less contrasty, specimens the quality may be poor.

One possible development of such computerised systems is the introduction of image analysis techniques. Here quantitative information is obtained on the shape, size and distribution of cell types. Such techniques are now everyday tools in professional microscopy.

What did it all cost, was it worth it?

A basic set-up like those shown in figures 3 and 4 costs about the same as a complete BBC computer system. (I wish my department had even one of those I hear you say). If modern instrumentation and associated techniques are to be introduced into the general run of schools these are the costs that someone, somewhere has to face.

As to usefulness and value the answer must be a definite yes. Every science teacher must have experienced the frustrations and uncertainties when pupils are asked to look down a microscope. Attempts to use microprojectors are seldom rewarded. Video microscopy presents the whole class with an example of what it is they should be seeking. Even at low magnification, giving a general view of the whole specimen, the results can be excellent. If one student's preparation has been particularly successful it can be transferred to the video system and shown to the whole class. A permanent record of that students results can be held on video tape to be used if the next group produce only disasters.

Future developments

Ideas are numerous and exciting. Teacher or students can produce a series of images illustrating a particular microscopic aspect of a topic. Such images can be mixed or edited in with other sequences showing whole organism or fieldwork aspects of the same topic. There is the facility to add commentary either live at the time of recording or dubbed on subsequently. Marrying these ideas to the use of the keypad for titles and labels brings the prospect of some powerful techniques to enhance learning.

One of the major limitations at present is the use of video tape as the recording medium. This has all the disadvantages of cassette tape as a medium for computer program storage. In both cases access to images or data is sequential. With cheaper video disc recorders and players on the horizon, we may soon have random access to images. Interactive video packages incorporating video-microscopy will then be possible.

Endpiece - specific equipment

Still-frame recorders

As indicated, only certain types of VCR will give good single frame images. The Panasonic range is that from which came the systems used by SSSERC staff or have been demonstrated to them. The supplier was Cameron Video Systems. We give details here only as an indication of price levels. There are other equivalent models on the market which in any case is undergoing technical upheaval. Cameras and combined camera-recorders are getting smaller, lighter, cheaper and having more features added. It is best to check with dealers and a local AVA centre for up to date information and prices.

<u>Sample prices</u> (VCR and accessories only).

4-head Panasonic machines, rough prices.

NV 180 portable	£580
plus a.c. adaptor/ charger	£80
plus battery (2 hours)	£30
plus timer facility	£260
Total	£950

A good still frame replay facility is thus available on a VCR with the same cost as a complete home video set up. Also suitable is the larger mains only Panasonic AG 6200. This is an industrial or commercial machine. Without a timer facility it costs approximately £1100. The camera is extra. The one we worked with was the Panasonic A1. This costs roughly £590.

We understand that the Canon range includes models which can match those of Panasonic. JVC is another marque noted for quality at reasonable prices. (For example see those parts of the article originated by Phil Donnelly). At the time of writing we were unable to ascertain if they were offering a portable system with good still frame.

Reference

1. Education for the Industrial Society Project, "The Physics of Sport", J.C. Bell, SCDS Glasgow Centre, 1985.

Acknowledgements

The poem "Frogs" by Norman MacCaig has been reproduced with kind permission from "A Scottish Poetry", Oxford University Press, ISBN 0 19916030 9, 1983.

We are most grateful to Philip Donnelly for his willingness to share his knowledge and experience.

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INTERFACING NOTES

Interface reviews

Abstract

This article up-dates the main developments in commercial interfaces and software for education, since the review article published in Bulletin 137. We pose some pertinent questions for newcomers to consider before they venture further with interfacing. Also included are detailed reviews of two interfacing packages at opposite ends of the market in terms of cost; the Harris 4-channel connecting box with 'Datadisc' software, Unilab interface with 'Grapher', 'Unicos' and 'Teller' software.

Introduction

Three years are a long time in interfacing. In Bulletin 137 we "stuck our necks out" and proposed tentative specifications for microcomputer data capture devices and related software. With educational computer interfacing in its infancy there was wide variation in the quality of commercially produced hardware and software. Each manufacturer had their own ideas about what was required by the teacher and sadly, much of the software fell far short of being user-friendly.

It is therefore pleasing to note that many, if not all, of the features proposed in Bulletin 137, can be seen in today's interfacing packages. Indeed, many software writers have gone beyond what any of us could have envisaged.

This article is supplementary to Bulletin 137 and should hopefully keep teachers up-to-date with current developments. We therefore recommend the original article to any newcomers to interfacing, as useful background reading. Because Bulletin 137 was 'sold-out', only photocopies of the article are available. Here, as in 1983 we aim to:

1) identify the interfacing requirements for science and technology teachers and therefore outline what to look for in hardware and program design.

2) suggest ground rules to help teachers and designers in the evaluation of future developments.

Firstly we concentrate on what's been happening since '83 and continue with detailed reviews of two contrasting interface packages. The Philip Harris 4-channel connecting box and 'Datadisc' software, at £50, is suitable for medium to long term data capture only and should be useful to chemists and biologists. The Unilab interface and software, at over £200, offers better computer and interface protection. It is designed for both fast and longer term data capture and therefore meets more of the physicist's demands. For the physicist and technologist alike there are facilities for the digital and relay control of external devices as well as the ability to measure frequency.

Anyone wishing more information about any interface or related software mentioned here, should contact SSSERC for details. Even better, arrange a visit to the Centre and, if the gear is available, we'll show you it in action.

Look out for further reviews of interface devices and their software in forthcoming bulletins.

Developments post-1983 - an overview

A. Hardware

Since 1983 the hardware features of computer interfaces have seen limited development whereas the technologies of electronics, robotics and control appear to have demanded greater attention. Witness the prolific development and wide acceptance of MFA and Control Pathways from Unilab.

VELA

On the data capture side one system that has seen no lack of development and support is the VELA datalogger from Educational Electronics. VELA is unlike other interfaces in that it is essentially a computer with its own comprehensive facilities for data capture and frequency measurement. It is therefore an 'intelligent' interface and can be used stand-alone. Other interfaces require a computer to carry out the A-D conversion or processing of data.

The first generation VELAs were undoubtedly less than perfect and we have said as much in these columns. However, many of the shortcomings of the original machines have been corrected. Today's VELA is a much-improved beast.

The development of sensor modules, additional utility and specialist ROMs and the tireless work of the Leeds University based VELA Users' Group have greatly extended the usefulness of the basic device. Indeed, many sensors/transducers of commercial and diy design incorporate bipolar outputs specifically tailored to VELA's inputs e.g. the Philip Harris 'Sensors for All' range.

Philip Harris

Philip Harris have concentrated on refining their disc-based software whilst keeping the hardware side as simple as possible e.g. 'Datastore' with a single channel analogue port connector and 'Datadisc' with the 4-channel connecting box.

They have also improved their single channel 'Analogue Converter', designed for fast data capture applications, with a Mk. II version. In keeping with their own sensor outputs and those of many others, a 0-1 V input is now available. This is in addition to the original 0-5 V and 0-(+/-5 V) inputs.

Griffin

The Interspec Interbeeb and I-pack interfaces have been renamed by Griffin as the 'Interpack 1' interface. Note that this hardware is no longer stand-alone as you require a computer specific plug-in 'Intercard' module to complete the interface. If you want to use the 'Interpack 1' on any other computer then all you need to buy is the 'Intercard' module for that computer. The facilities available when Intercard and Interpack are linked are identical to those of the superseded stand-alone models.

Griffin also supply a 'Technology Interface' for controlling motors, solenoids, lamps etc. and for accepting switch inputs. It uses the 'Intercards' in the same way as the 'Interpack'.

Also available from Griffin is the Expand-pack 2-channel board which allows a wide range (mV up to 50 V) of analogue input signals to be matched to the fixed 0-2.45 V input of 'Interpack 1'. Sensitivity and offset controls are provided.

B. Software

The quality of data capture and control software has seen steady improvement. The strait-jacket on programers of BBC Basic has always been the limited memory capacity of the Model B, especially when in high-resolution screen modes. The speed advantages of using floppy discs instead of cassette based software has led to more interfacing programs being offered in disc format. Most suppliers now realise that the vagaries of cassette loading are not suffered gladly by teachers.

Unilab

Unilab have certainly been busy, enhancing the original suite of programs for applications of the Unilab interface. They have improved the already excellent data capture software 'Grapher' and added 'Scanner', a less sophisticated but nevertheless useful, digital oscilloscope utility program. The range is further extended with specialist software for frequency measurement and radioactivity analysis, namely 'Freq2' and 'Teller'. Also available is ROM-based software, 'Unicore'. This extends the power of the BBC Basic vocabulary, enables commands to be integrated into Basic programs and allows direct configuration or control of all inputs and outputs on the Unilab interface.

Philip Harris

As mentioned earlier, Philip Harris have increased the sophistication of the software and kept the hardware simple. Their 'Datastore', 'Datadisc' and Analogue Converter Mk.II software are excellent value for money considering the wide range of facilities they offer. 'Datadisc' has a useful facility to download data from VELA and display it in various forms. Other facilities include plotting one channel against another, best straight line fit, smoothing of data, mathematical operations on data and input of data from the keyboard. The A/D Converter Mk. II software is icon based and very easy to use. In many respects these programs show how much software has advanced in quality since 1983. A science department could do worse than buy the Datadisc and A/D Converter packages for a total of around £100.

VELA utilities

Educational Electronics have updated their 'Velanalysis' program with an improved Mk. II version. The program allows transfer of VELA data to the BBC micro, displaying it in graphical form. The means to access individual data values to the save these on disc are also provided.

Anyone with a VELA, whether it be a MkI or Mk.II model, should subscribe to the excellent VELA Users' Group, based at the Physics Department of Leeds University and headed by the ever-enthusiatic Dr. Ashley Clarke and Dr. Jones. For a yearly subscription of £2 you get six issues of a 'Newsletter' (usually 25+ pages) containing a mass of experimental ideas from practicing teachers and news of hardware and software developments. For example, the latest issue details a 'Utilities' disc, to be made available in December, for real time graphical and digital display of VELA logged data, on the BBC micro.

Griffin

It is a little disappointing that the Sinclair Spectrum has not seen much software support for a major interface, the Interspec I-Pack. Even the present version from Griffin, the Interpack, appears to have little software support. This is possibly as much a fault of the unreliable Sinclair 'Microdrive' cartridge software as anything.

The future?

With the advent of the BBC Master series of computers, presuming they ever find their way into science departments, memory restrictions should become less of a problem. Programers will have a freer hand to integrate data capture software with spreadsheet, database and wordprocessor. This should considerably widen the scope for imaginative presentation and handling of data. In the next section we pose some questions for those interested in venturing further with interfacing as well as a discussion of the whys and wherefores of its implementation.

General remarks

Why, when & where interface?

It is evident from our experience of 'Interfacing Roadshows' and exhibitions that there is an all too prevalent reaction to interfacing as a "good thing to get into" but "why, when and where do we use it?".

Good software and flexible experimental methods should allow the user to easily repeat experiments under slightly different conditions and analyse/display data in a variety of forms. Even so:-

How many teachers actually consider the way pupils perceive computer generated graphical data or control sequences?

Do children find a pH curve on screen any more meaningful than one in a textbook?

What advantages accrue from the use of data capture devices as opposed to stand-alone instrumentation?

Does the interfaced experiment necessarily enhance the learning of the student?

Can an interfaced experiment really be done more quickly and therefore with greater ease of repetition than by conventional means? Consider the time to set up computer, monitor, disc drive, software, interface.

Could an experiment be done more cheaply and less abstractly by low-tech means?

Such questions are not intended to put off the prospective user, be they teacher, curriculum developer or in-service trainer. They should however, once answered, offer some pointers as to the 'why' of 'why interface?'.

Interfacing need not be prescriptive, once the ability to operate the hardware and software is gained. It should open up new experimental and investigative routes for the enquiring scientific mind to explore.

Is interfacing feasible?

Given that interfacing is justifiable in an educational sense, a number of points, related to implementation and resourcing, still remain to be considered:-

1. How many science departments possess, or even have access to, a computer and interface with the necessary portability for use in a number of laboratory locations?

2. Any expansion of interfacing applications in the school science lab. will have major implications for:

a) **Teacher and technician training** - For the application of interfaces to be successful, teachers must be made aware of the facilities offered by the new generation of interfacing equipment through familiarisation and applications courses. Of equal importance is the need for technicians to be adequately trained in the setting-up and first-line maintenance of interface equipment. This is in addition to the 'normal' technician work involving the circuit construction of sensors, light gates etc.

b) **Equipment provision** - Is it feasible to have 'one-per-desk' computer/interface stations in the science lab of the future? One cost-effective alternative is possibly individual pupil ADCs/data loggers without processing power and one or two data analysis micros per lab. Science departments may fall heir to BBC Model B 'cast-offs' from maths and computer studies departments if and when they upgrade to more powerful machines.

On the control side, should we have individual input/output modules with a variety of controllers cf. Unilab/MEP 'Control Pathways'?

Specific comments

There are obvious difficulties in recommending a best-buy from the range of interfaces because of variation in facilities offered and the differing needs of science disciplines. Some interfaces are clearly designed for simple data capture. Others can cope with data capture and control, have better computer-protection specifications, and not unexpectedly, tend to be more expensive. An additional problem is that currently, there are few nationally defined educational priorities or curricular slots, specifically requiring the use of interface equipment.

As there is insufficient space to describe, in detail, all the software and hardware developments since Bulletin 137, we concentrate in this bulletin on reviews of the 'Datadisc' 4-channel package from Philip Harris and the Unilab interface and software.

We recommend that chemists and biologists look first at 'Datadisc' as a reasonably cheap entry point into interfacing which should satisfy most of their requirements. If you want to cut costs still further we suggest you read 'Interfacing Notes' in Bulletin 140 for the design of a d-i-y analogue port connector. The article in 140 is also useful for those unfamiliar with the ins and outs of d-i-y interfacing.

Physicists will find limitations in the 'Datadisc' facilities for data capture of fast transients or timing and acceleration measurement. The Unilab hardware is more sophisticated than the 'Datadisc' system and is therefore more expensive. Although suitable for all departments the software tends to be orientated more towards the physicist and technologist.

Datadisc software, connecting box (4chann.) & lead
Cat. No. A29015/4, £49.95
(available for the BBC micro only)

Datadisc software only
Cat. No. A29017/8, £25.00

Connecting box & lead only
Cat. No. A29022/1, £25.00
supplied by Philip Harris

Connecting box

In Bulletin 137 we looked for simplicity in hardware. This design is certainly uncomplicated (Fig.1). It is, in fact, a nicely packaged version of an analogue port d-i-y connector of the type outlined in Bulletin 140.

This interface has no on-board analogue to digital converter (ADC). All A-D conversion is done by the BBC micro. In consequence the rate of conversion is determined by the Beeb's ADC and thereby the minimum duration of events that may be measured is limited.Flat-out, it can take 1000 readings over a period of around 5 seconds.

An integral ADC is necessary for the high rate of data capture required for the analysis of transient events. Many data capture devices have their own ADC and are therefore more expensive than the £50 asked for this box and software package.

Additionally you have to put up with the three diode chain used as the internal voltage reference in the Beeb. This can allow voltage measurement to drift by about 5% over three hours as the Beeb warms up. For a circuit design to overcome this problem we refer you to page 10 of Bulletin 143.

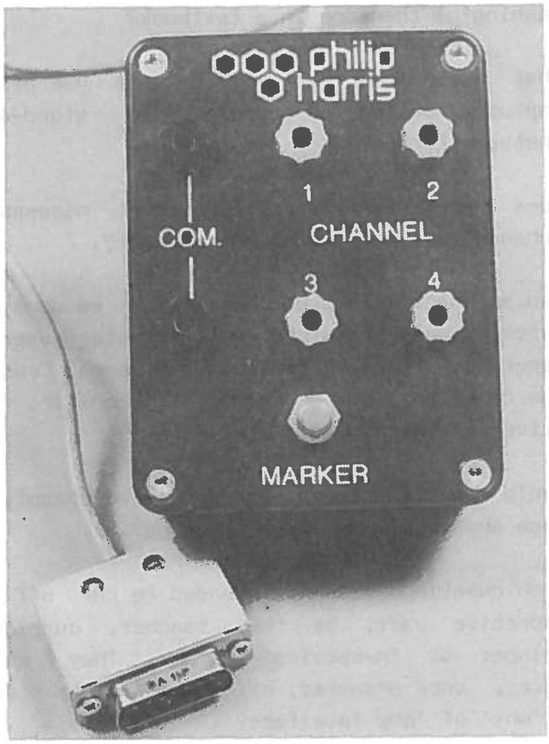

Fig.1

Connection to the computer is by a d-type plug to the rear-mounted analogue port socket on the Beeb. The box has six 4 mm sockets; 4 red; one for each of the analogue channels and 2 black which are ground. There is also a push-button switch for logging data at non-standard time intervals (Fig.1).

In use it is a simple matter to connect sensors/transducers with suitable voltage output (0-1.8 V) or laboratory instruments having the typical 0-1 V chart recorder output. The Philip Harris "Sensors for All" and Griffin "MEP Analog" sensor modules have suitable outputs. The 'Datadisc' software allows each channel to be calibrated and displayed graphically in the desired units.

As long as the inherent advantages/disadvantages in the design of commercial transducers are recognised, they may provide an easy, if expensive, route to fuss-free interfacing when used with the connecting box.

With d-i-y sensors you must ensure that the voltage output falls within the 0-1.8 V range under all conditions. We strongly suggest that the output from any sensor, d-i-y or commercial, is monitored using a digital multi-/voltmeter, before connection to this interface.

Protection

If left unprotected, the ADC chip in the Beeb is vulnerable to damage from reverse polarity and voltages greater than 1.8 V. Each channel of the connecting box is protected by a 10 kΩ resistor in series and a 4.7 V Zener diode in parallel. The resistor gives protection to around 20 V of overvoltage with the Zener diode giving some additional protection against reverse polarity. Some early versions of the box may not have this protection as the instruction booklet we have recommends the fitting of Zener diodes and resistors.

Note:- As mentioned previously, the Datadisc software may be used with the d-i-y analogue connector outlined in Bulletin 140. However, it has no protection for the computer against reverse or over-voltage and we would therefore recommend the application of one of the protection methods shown in the same Bulletin.

'Datadisc' software

The 'Datadisc' software is menu driven and provides a disc-management system for recording, displaying and saving to disc, voltage data captured by the 4-channel connector.

Disc management utilities and data are held as separate programs and files, with only the minimum necessary information in computer memory at any given time. Because the disc is continually being accessed for data or programs the system can appear sluggish to the experienced user. The menus, which are shown in clear, double-height teletext characters, allow you to pass easily from utility to utility.

As management utility programs take up almost all 100K of a single-sided 40 track disc there is little room left on the 'Datadisc' for data files. They can be saved to the reverse side of the 'Datadisc' disc, if you have a double sided drive, or on a separate disc if you have single or twin drives. Label the separate disc "data disc" at your peril. The use of 'Datadisc' and data disc (see what we mean) on a single 100 K drive is not recommended. You are prompted to change discs with a frequency which makes life extremely laborious.

Documentation

An excellent 9-page booklet is supplied and gives a comprehensive guide to the operation of the software.

Features

The following facilities are available with the 'Datadisc' software:-

Calibration

Each channel may be calibrated and graphs labelled to register incoming voltages in the required units. During the calibration procedure a bar-graph indicates the voltage input in the range 0-1.8 V.

For example, a temperature sensor is placed in cool water and the temperature read from a mercury thermometer. The sensor produces a voltage equivalent to this temperature which is keyed into the computer. The procedure is repeated with hot water. The program assumes a linear relationship between voltage and temperature within and beyond the calibration voltages. If the temperature sensing circuit is not linear, such as may be found with thermistors, then this procedure may cause errors when graphs are plotted.

Some instructions for commercial sensors state the relationship between measured voltage and the 'real' units. In this case, the voltage may be logged first and the data operated on by a mathematical function later. See section on 'Mathematical Utilities'.

Hide the <ESCAPE> key

A thoughtful facility is provided to prevent both inadvertent and deliberate interruption of data capture. The <ESCAPE> key can be 'hidden' by programming a user-defined key sequence to replace its function.

Saving and loading data files

Previously saved data and any calibrated settings may be loaded in from disc. A neat touch allows the user to enter a few lines of text which serve to explain about the saved data. This may contain information such as date recorded, location, equipment used etc. If the data is loaded in at a later date this information is displayed as it loads in. Another excellent feature is the provision of simple on-screen messages and graphics which inform the user that "the computer is processing or has completed the last specified task". It happened all too often in the past that the user was left looking at a blank screen with no message as to whether the computer was processing information or had simply crashed.

Keyboard data

Data can be entered directly, one reading at a time, through the keyboard. This is useful, if only to illustrate the advantage interfacing can have over observing, recording and keying-in results to the computer. Graphs are automatically scaled to give the maximum expansion to the Y-axis.

VELA data

There is also the facility for up to three channels of data to be exported from the data-logging device VELA to the 'Datadisc' software; the fourth channel contains details of time intervals. See Fig.2 for an example of such data. The three meteorological parameters shown are light level, barometric pressure and temperature. If you have a VELA, the software is worth buying for this facility alone, especially when it is compared with the Velanalysis Mk. I software.
[Note:- Velanalysis has been updated with a Mk.II version].

Recording options

The connecting box and software are designed for measuring medium to long-term events. The data capture of fast transient events is not immediately possible as there is no automatic triggering, although Philip Harris say in the instructions that it is technically feasible to apply a high logic signal to pin 10 of the analogue port to signal the start of data capture.

You have essentially the choice of fast recording on a single channel i.e. 1000 readings over a period of 5s or slow recording on up to four channels simultaneously. 1000 readings are taken on each channel over a minimum time equal to 10 s x number of channels in use, e.g. if three channels are in use the minimum time over which data may be logged is 30 s with 30 ms between readings.

It is also possible to capture data at irregular intervals with a push-button switch on the connecting box. This could be useful when data from two channels, neither of which monitor time, are to be plotted against each other.

Display options

All, or user-defined sections, of the data, captured on one to four channels may be displayed against each other, or against time, in digital or graphical form.

Graphical displays

When more than one channel of data is plotted against time the graphics verge on the 'chunky' side (Fig.2 - meteorological data transferred from VELA). This illustrates the memory restrictions of the basic BBC Model B. As more data is loaded into memory there is less space to display it in a high resolution screen mode. However, the mode used for the display of one channel is satisfactory (Fig.3). This figure illustrates data capture of the temperature rise, due to heat of neutralisation, when 0.1 M NaOH is titrated with 0.1 M HCl.

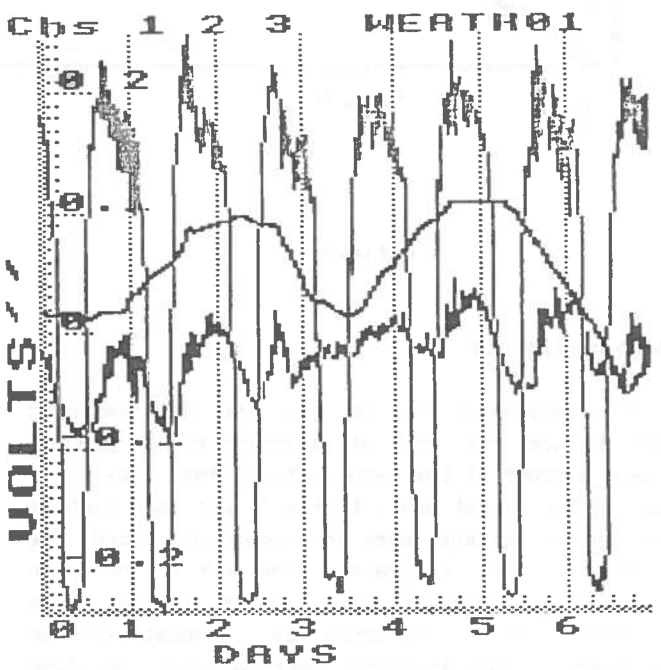

Fig.2

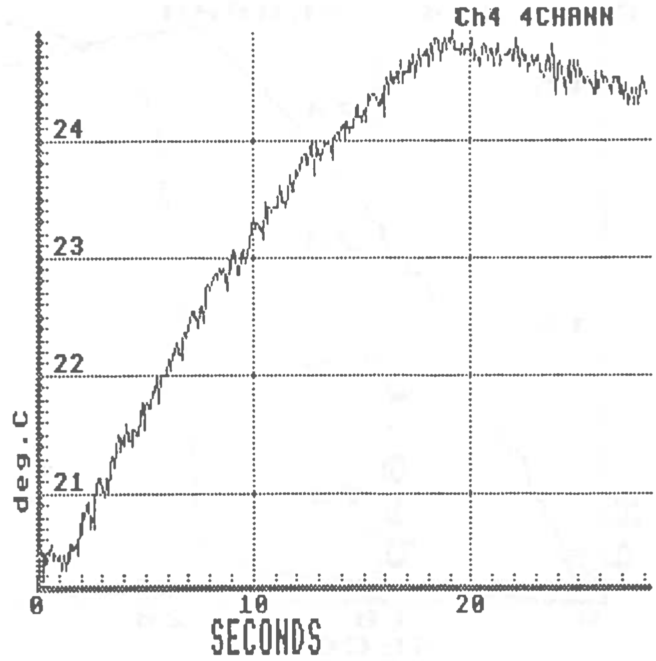

Fig.3

X-Y plots

As well as displaying data against time, the software allows data on individual channels to be plotted against each other. This can provide some novel and thought-provoking graphs.

Fig.4 shows the temperature data (Fig.3 data smoothed) and pH data from the neutralisation experiment mentioned previously, plotted vs. time on the same graph. Compare this with the X-Y plot of pH vs. temperature using the same data (Fig.5).

Fig.6 shows an X-Y plot of pressure vs. temperature as air inside a round bottomed flask is heated from 20 °C to 100 °C. Note:- you have the choice of a point plot as in Fig.6 or line plot as in Fig.5.

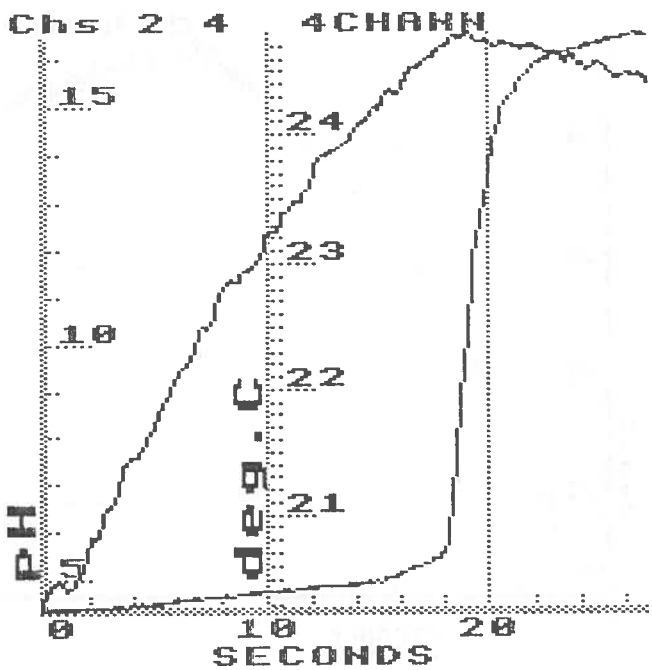

Fig.4

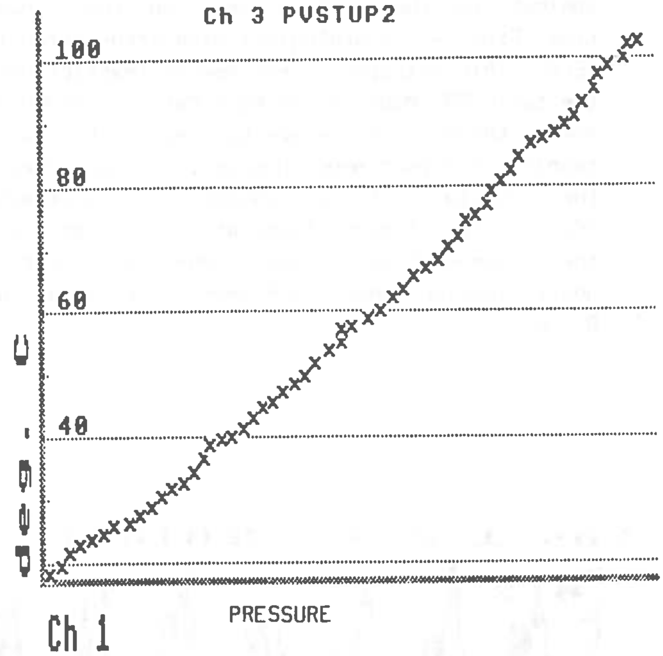

Fig.6

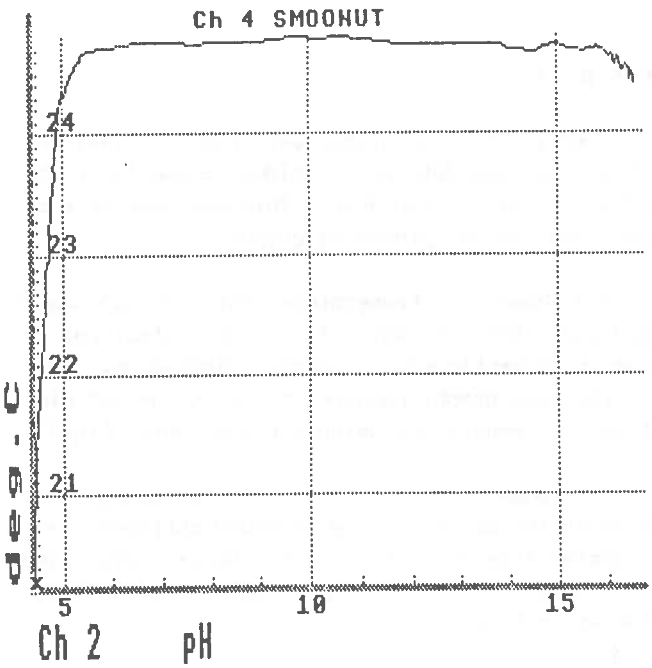

Fig.5

Windowing-in

It is advisable that sensors are not switched off before the end of recording as the program takes account of the zero voltage. The Y-axis is set to the widest scale that will plot the highest and lowest voltages over the recording period. The resultant plot compresses the part of the graph where the voltage may have varied little. This problem can be overcome by windowing-in on sections of data recorded over a user-specified time interval. It is therefore possible to examine in detail the changes in voltage at what may be an interesting part of a graph.

Compare Fig.7 which looks at the period 2-4½ days with the complete data of Fig.2. Taken too far however, this technique can produce wildy exaggerated plots of data that may vary little in magnitude.

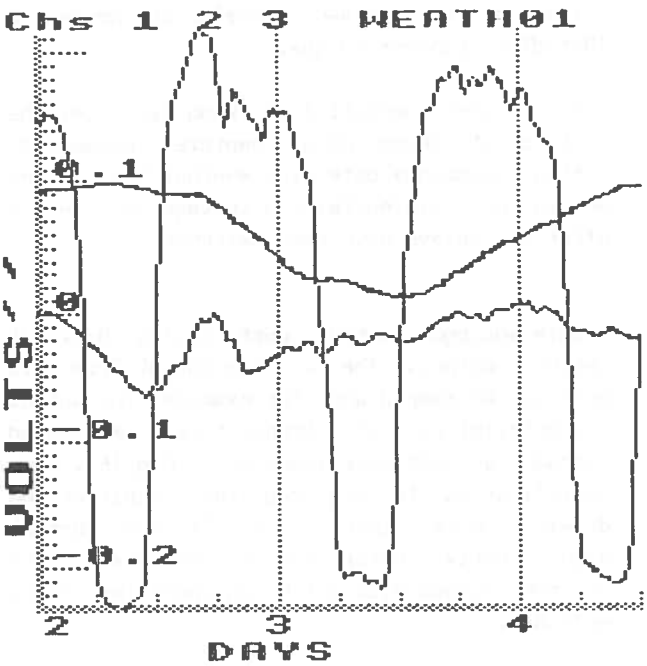

Fig.7

File jiggery-pokery

The disc management utility program gives data from each channel a library prefix letter in its filename when saved e.g. channel 1 is saved as "A.DAY1", channel 2 as "B.DAY1" and so on. It is therefore possible to compare on the same graph, data recorded on different days e.g. A.DAY1 & A.DAY2, provided the total recording times were the same. Simply rename datafile A.DAY2 as B.DAY1 and call up file DAY1. Make a backup of your original data before trying anything like this as your original B.DAY1 will be overwritten.

Printer dumps

The software includes an in-built printer dump routine for hard copies of graphs on Epson compatible printers. The printer dumps shown in this article were obtained in this way. Note the useful display on all graphs of the filename. An alternative dump that uses the advanced features of the latest generation Epson FX series is also provided as well as the facility to configure the program to use your own printer dump.

Mathematical utilities

Function operations on data

Any captured data may be operated on by user-defined mathematical functions e.g. log Y, (2*Y)-10 and then plotted as the new function vs. time. This can be useful for scaling graphs in the correct units with sensors that are difficult to calibrate using the procedure outlined in the 'Calibration' section.

For example, in the instructions supplied with the Philip Harris Electronic Barometer the relationship between atmospheric pressure in millibars (P) and the 0-1 V voltage output (V) is stated as **P = (0.1 V) + 950.**

To obtain pressure data in millibars you operate the function (0.1*V)+950 to convert the data recorded as a voltage (V). The new data P can then be plotted in the 'correct' units.

Data smoothing and best straight line

The mathematical utilities also have a best straight line procedure as well as one to smooth data. The smoothing of data is particularly useful before plotting one voltage variable against another. The data smoothing irons out the wild variations recorded on each channel so that the resultant X-Y plot is smoother. The facility is also useful for smoothing out 'noisy' data. See Fig.3 - noisy, Fig.4 - smoothed.

Concluding remarks

Philip Harris, through their software writers Abington Microconsultants, have found a way round many of the memory restrictions inherent in the standard Beeb. With imaginative use of the Beeb's different screen modes, they have produced a comprehensive integrated suite of programs for use with the connecting box or any analogue port connector with adequate protection.

For simple no-nonsense data-logging there is little to beat the 'Datadisc' software. It is extremely well thought out and enjoyable to use. This package goes some way towards satisfying many of the essentials of good interfacing software. A

Physics department may find it of less immediate use than Chemistry and Biology because of its unsuitability for measuring transient events.

The connecting box is a little pricey for its basic construction. All is not lost however; any Scrooges out there can construct their own (ref. Bulletin 140) buying only the software. **Recommended.**

* *

Unilab Microcomputer Interface
for BBC Model B incl. manual, 34 way connecting cable and cassette software (Cat. No. 532.001, £163).

Hardware facilities

The hardware features of the 'big orange box' have barely changed since Bulletin 137. Unilab now sell versions of the interface for the Apple IIe (Cat. No. 532.002, £183.00 and the Commodore 64 (Cat. No. 532.003, £205.00). Today's interfaces have a less bulky, sleeker case with functional areas nicely partitioned and labelled.

The overall construction gives an impression of robustness and should therefore cause few problems in the tough environment of a school science department. There should be no restrictions connecting conventional laboratory instruments as standard 4 mm sockets are employed.

The hardware facilities (Fig.8) may be summarised as follows:

1. **Four-channel analogue input port** for data capture applications. Unlike the Philip Harris 'connecting box' the Unilab interface has its own A-D converter. It is therefore capable of much higher rates of data capture i.e. up to 125,000 samples per second. Each channel can be set to monopolar or bipolar mode over 4 sensitivities:- 0-0.1 V, 0-1 V, 0-10 V and a variable range 25 mV-2.55 V. An 'amplifier' knob operates as a gain control for the sensitivity on the variable range. Therefore the interface can accept a wider range of voltage outputs from sensors than the simple 0-1.8 V of the Beeb A-D converter and hence the 'Datadisc' connecting box.

   A 'trigger sensitivity' knob can alter the voltage at which data capture commences. Software commands determine whether the trigger occurs on a rising/falling voltage or directly after all relays have been switched on.

2. **Single analogue output port** giving 0-2.55 V latched output. The voltage output from this port may be ramped and, for example, the output characteristics of transistors monitored through an analogue input port (Fig.16). Some amplification is required for applications drawing more than 1 mA. If any current significantly greater than this is drawn, the voltage output will not be as specified by the software.

3. **Four latched changeover relays** on output lines. These are capable of switching 1 A at 25 V. Extremely useful for controlling low voltage motors, lamps, solenoids etc.

4. **Eight digital input/output lines.** The on-board 6522 VIA allows the TTL compatible lines to be selected in pairs as inputs or outputs. Digital inputs can monitor the states of switches and sensors, as well as for frequency and timing applications.

5. **1 MHz connection** to the computer bus. This leaves the facilities of the user and analogue ports on the BBC for complex control work.

6. **Electrical protection** for user and computer. There is full overload protection on all sockets against voltages commonly available in the laboratory.

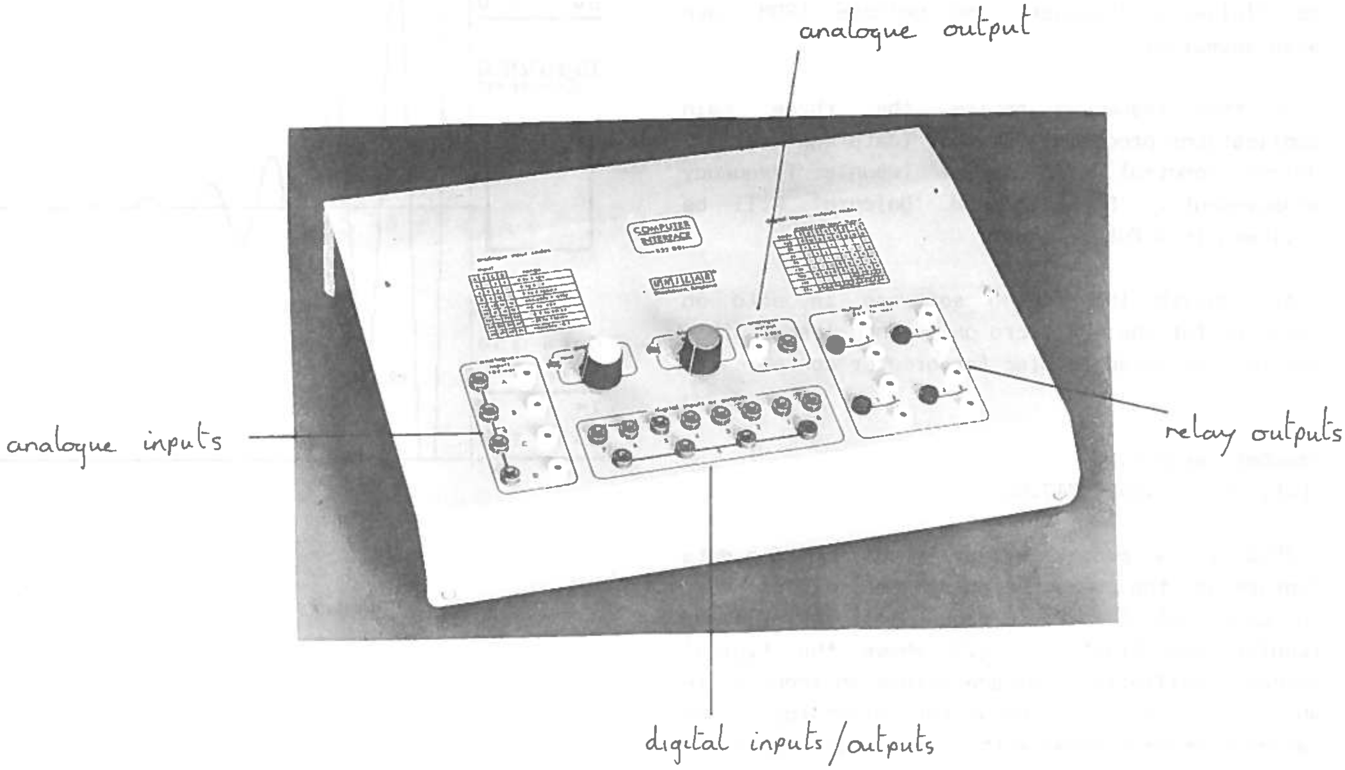

Fig.8

Software facilities

As with the 'Datadisc' package, the Unilab system has seen the most significant developments on the software side.

'Free' software

A comprehensive 37 page instruction manual and a bundled selection of programs on cassette are supplied with the interface. The programs, which are a mixture of Basic and machine code, cover timing, velocity, acceleration, data input/output and relays. Some simple experimental set-ups for the programs are outlined in the manual and are used a means of finding your way around the interface. They seem a little restrictive when compared to 'Grapher' and 'Unicos' but are nevertheless useful for getting started.

djb microtech

You may also have seen adverts in School Science Review for software and teaching material by a Scottish company called djb microtech. Three software packages for use with the Unilab interface have been published thus far. They cover 'inductors & dc' and 'capacitors and dc', £17.50 + £1.00 p&p each and 'ac investigations', £19.00 + p&p. The software is supported by comprehensive teacher's notes and student worksheets. A double pack covering 'mechanics measurements and applications' will, it is understood, be available by Christmas.

'Grapher', 'Unicos' & 'Teller'

The main Unilab data capture program 'Grapher' has been updated and improved. New programs such as 'Teller', 'Scanner' and 'Unicore' (ROM) have also appeared.

In this issue we review the three main applications programs:- Grapher (data aquisition), Unicos (control) and Teller (counter/frequency measurement). 'Scanner' and 'Unicore' will be reviewed in a future issue.

All Unilab interfacing software is sold on cassette for the BBC micro only. Once loaded they can then be saved to disc for greater convenience.

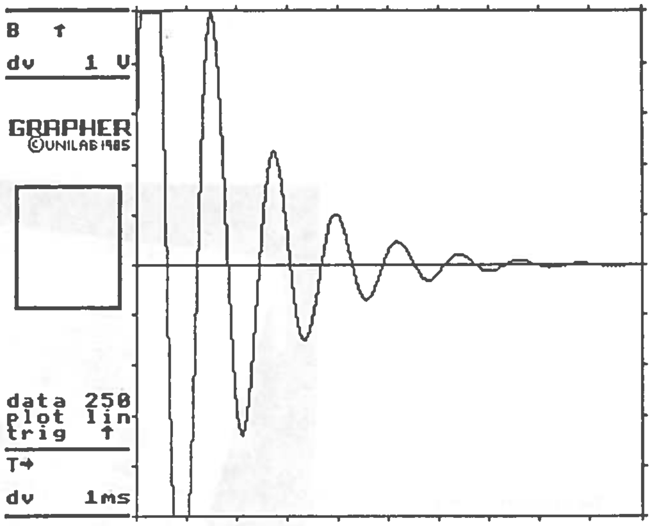

Fig.9

Grapher issue 2.00
(Cat. No. 532.052, £17.00)

This is a program primarily designed for data capture and the presentation and analysis of data in graphical (Fig.9), large digit (Fig.14) or tabular form (Fig.13). Fig.9 shows the typical damped oscillating voltage across an inductor in an L-C circuit as a capacitor discharges. The cassette program comes with a very well written 28 page instruction manual containing some useful ideas for data capture experiments. The present version, issue 2.00, bears a copyright date of 1985 on screen and supercedes the earlier versions that displayed "UNILAB 1984".

The main area used on the interface hardware is the four-channel analogue input port. In typical Unilab style the Grapher displays are separated into distinct functional areas (Figs.9 & 10):-

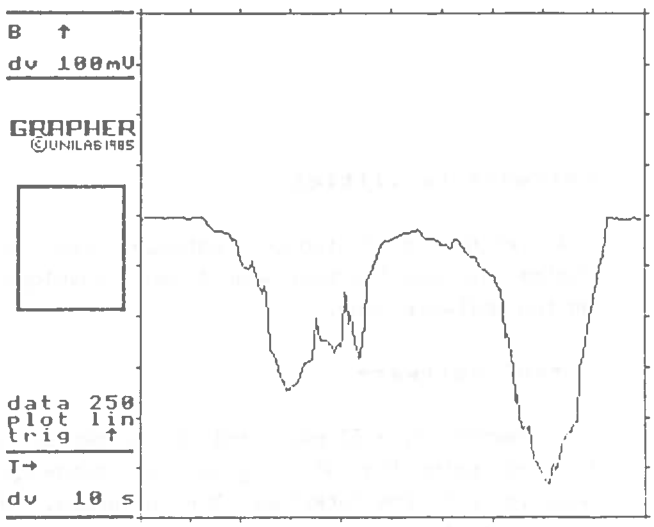

Fig.10

top left box displays the analogue channel(s) (B), plotted as the Y-axis of the graph. The scale divisions (dv) for this input are also given (100 mV/division in the example shown). The user may select, by choosing the YRESET command one of four pre-set, or one variable, voltage sensitivity scales.

bottom left box details the scale for the X-axis and which of three modes of data aquisition is in operation. These can be time (T), voltage input to analogue port (A) or a ramping (R) voltage from 0-2.55 V from the analogue output.

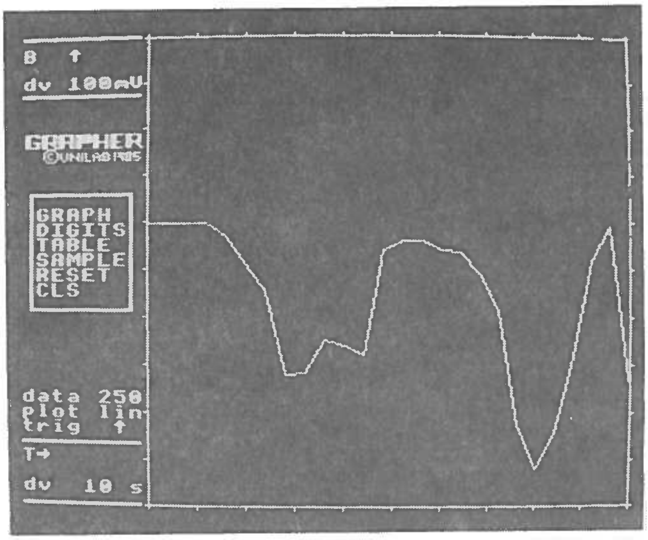

Fig.11

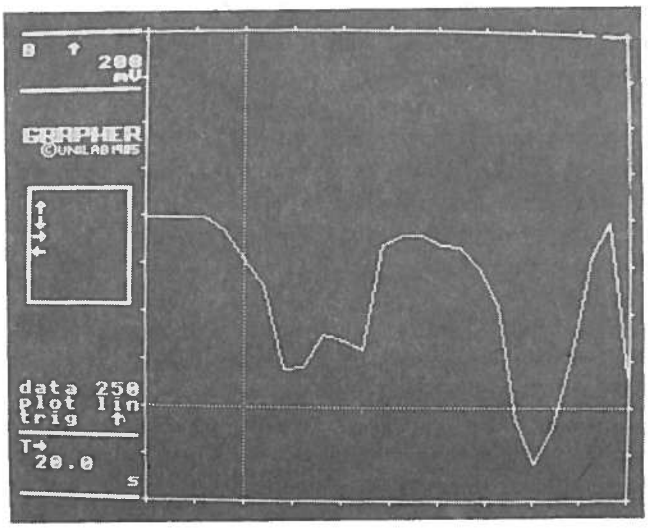

Fig.12

centre left box contains the commands that are at any stage available to the user. The program structure consists of a number of command panels for loading settings and/or data, resetting the axes' function and sensitivity, sampling and displaying data, analysing data and outputting settings and/or data to disc, printer or chart recorder.

The movement from panel to panel is achieved by presses of the space bar and is very simple and easy in operation. Displayed stems of the abbreviated commands are enabled by pressing the first letter only. The commands in the latest version of 'Grapher' are slightly longer than the original and are therefore easier to understand. Once you become attuned to the overall command panel layout and reset procedure the software is remarkably easy to use considering its power. Note that the command panel is blank when a screen is saved to disc. For an example of a screen shot showing commands in this box see Fig.11.

If you want to keep your sanity we would strongly suggest that the line <*FX210,1> is placed in any !BOOT file (it switches off the Beeb sound). Otherwise, the program 'beeps' at almost every key-press and becomes very wearing.

By selecting the relevant commands Grapher allows you to:

a) sample one variable voltage against time or against another variable voltage and to plot the results on a graph. All graphs are displayed in BBC Mode 4 giving a satisfactory resolution. The variable voltage may be from an external source such as a sensor or a ramp voltage generated by the interface.

The time interval between each of 250 readings can be varied in a number of pre-set steps between 0.2 ms and 100 minutes. Graphs can be superimposed on one another (Fig.15) and displayed with variable resolution (plot every one of the 250 readings or every second, fifth or tenth one. Compare Fig.10, where every reading is plotted, with Fig.11, where every tenth reading is plotted. Figs.10 & 11 show the 0-1 V output from a Philip Harris light sensor under varying lighting conditions. Fig.15 illustrates the response of an light dependent resistor to a mask, dropped from three different heights, dropped in front of it. You can see why the LDR is unsuitable for dynamics experiments, given the slow response to light-dark transitions.

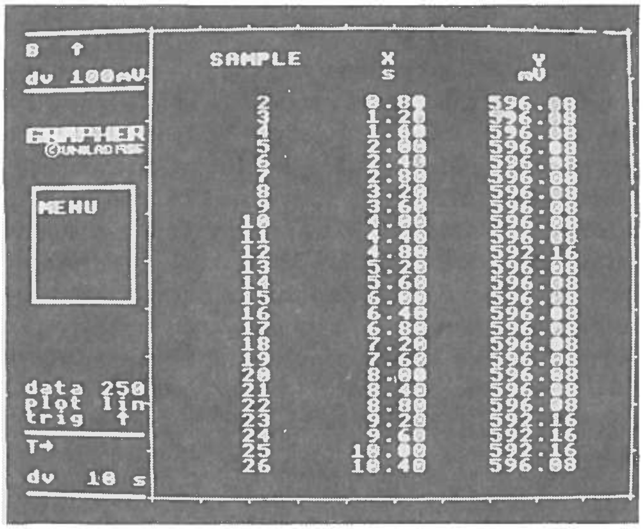

Fig.13

b) sample the difference between two voltage variables vs time or vs a third voltage variable and plot the results on a graph.

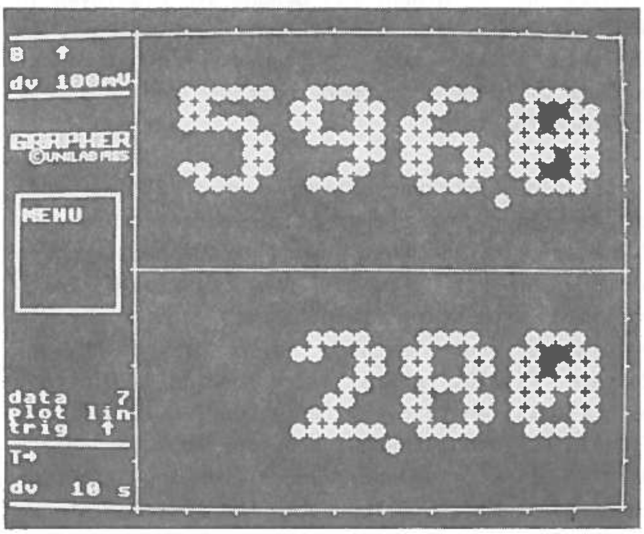

Fig.14

c) also display results in tabular (Fig.13) or large digit (Fig.14) form. This data corresponds to the graph shown in Fig.10. The large digits are big enough for demonstration purposes in a lab.

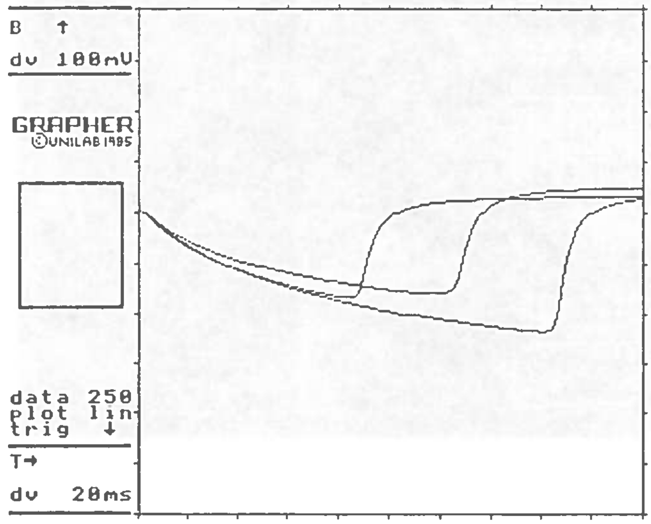

Fig.15

d) abstract information about X & Y co-ordinate values, gradient and areas from graphs, using cursor lines. With educational software, this is a unique and extremely useful set of graph-analysis commands (Fig.12).

e) output results in tabular form (Fig.13) to a printer or to a chart recorder. Note that there is no printer dump available within the Grapher software for outputting screen graphs to a printer.

f) save data and/or graph scale settings to tape or disc. When data and settings are saved by the 'DSPOUT' command the Mode 4 screen is saved as the "filename" + "S". The screens shown in this article were dumped to an Epson printer using the <u>Computer Concepts</u> 'Printmaster' ROM.

It is possible to save only the scale settings so allowing accurate repetition of experimental set-ups at a future date. A library of settings for favourite experiments could be a useful time-saver in the lab.

Concluding remarks

This software is well worth the £17 asking price. It is flexible, powerful and surprisingly easy to use. The Grapher software does not have the facility for simultaneous four-channel data capture and display a la 'Datadisc'. The limit of multichannel capture is two channels versus time or a third channel. Taking this with the ability to examine fast transient events, this software may be more suited to physics than other science departments.

* *

Unicos

(Cat. No. 532.051, £10.00)

This software allows you to configure the Unilab interface for a number of control, timing and data capture applications. A high level language, akin to Basic, enables a sequence of instructions to be passed to the interface. A comprehensive 22 page booklet is supplied and contains a number of useful examples of simple Unicos routines.

The program starts with a Command menu with keywords to NEW, CONTINUE, EDIT, RUN, LOAD, SAVE and *CAT. Programs can be generated, one line at a time, from a Keyword menu. This contains the vocabulary of instructions which may be used in a Unicos routine. Such instructions include INP (input), OUTP (output), CMP (compare), JMP (jump), FN (function), VDU (display on screen) etc. When one of these keywords is selected the user is further prompted for extended instructions, such as ANALOGUE or DIGITAL, until a program line is completed. The software is similar to 'Grapher' in that only the first letter of keywords and commands is required.

The following routines, or combinations of them, may be performed by Unicos generated programs:

a) data capture through the four-channel analogue port.

The following example of a Unicos program looks at analogue input B with a sensitivity scale of 0-1 V and returns a numeric variable X.

```
1 INP ANALG B 1V X
2 VDU DIG X
3 JMP 1
```

The variable X is directly proportional to the voltage and is displayed on screen in large digits by line 2. Line 3 'jumps' back to line 1 again and the monitoring of the analogue input continues.

b) software control of output voltage through the analogue output port.

```
1 OUTP ANALG 0,1 X
2 JMP 1
```

This example 'ramps' the output voltage by 0.01 V each time the routine completes a loop.

c) configuration of the 8 digital lines as input or output pairs.

```
1 OUTP DIG 0
2 DLY 50
3 OUTP DIG 1
4 DLY 25
5 JMP 1
```

The example routine mirrors the logic state of digital output 0. An LED and resistor connected in series flashes on and off.

d) software control of external devices through 4 latched relay outputs.

This routine switches all relays on and off at 100 centisecond intervals.

```
1 OUTP RLY 0
2 DLY 100
3 OUTP RLY 15
4 DLY 100
5 JMP1
```

Note that the 15 of OUTP RLY 15 corresponds to the four bit binary code 1111 i.e. all relays are put to logic 1.

The real power of Unicos is realised when routines include analogue input/output, digital input/output and relay switching in combination in the one program. Sensors and/or digital switch inputs can be monitored via the analogue and digital inputs. Their voltage output can then be used to switch digital outputs and/or relays to switch on low voltage motors, lamps etc.

There are obvious technological applications in process control. The principal limiting factor is the restriction of 32 lines per program. The voltage from the analogue output can be software controlled and the voltage output characteristics from components such as capacitors and transistors monitored through the analogue inputs.

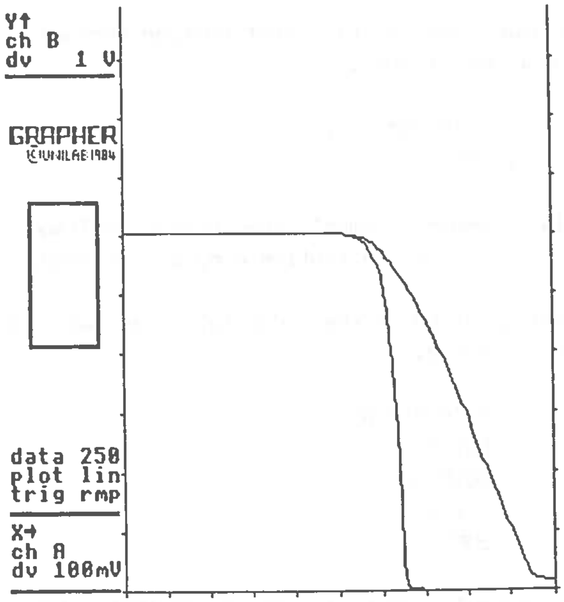

Fig.16

Fig.16 shows the switch-on characteristics (voltage across collector and emitter) of a transistor as the voltage across the base and emitter is ramped up. A digital output can also be programed to provide the on/off pulse train to 'step' stepper motors.

Concluding remarks

Unicos provides an extremely useful introduction to control through a reasonably friendly, easy to understand, control language. For programing simple applications, there is no reason why students could not devise and test out their own software. At the same time the programing concepts of delays, loops, counters and conditional branching can be seen as tangible effects on real equipment e.g. motors, lamps etc. rather than abstract movements of blobs on screen or 'beeps' from the computer.

For more experienced users, the Unicos language can be frustrating. This is for the same reasons that computer buffs start gnashing their teeth when GOTO statements appear in Basic programs. It is unfortunate therefore, that the Unicos 'operating system' departs from BBC Basic in not having procedures. In some ways it is similar to machine code in that IF..THEN..GOTO statements are enacted by COMPARE and JUMP. The JUMP statement has all the disadvantages of GOTO because the insertion of a line at the start of a program puts all the JUMP numbering out.

Whether you want your pupils to learn bad programing habits by using JUMP statements is worth considering. Unilab would do well to make the next generation Unicos program procedure-based, if at all possible.

It is hard to tell who will find the most use from this program. There may be something for everyone, from the biotechnologist to the physicist. Because it is essentially a simple high-level operating system for the Unilab interface it is really up to the imagination of the user to apply the language as a tool to suit his or her requirements.

* *

Teller
(Cat. No. 532.057, £10.00)

This program offers facilities for counting discrete events and measuring frequencies of TTL type logic pulses through digital input 6 of the Unilab interface. The facilities are therefore particularly suited to the analysis of radioactivity experiments. Data can be displayed as a histogram, table or large digits.

Teller has a similar program structure to the 'Grapher' data capture software with catalogue, load, reset, calibration, sample and load command panels. The screen layout with X and Y axes information and command box is also very similar. Facilities for saving settings, data and screen displays to disc are also included. The cassette based software comes with a comprehensive 20 page instruction booklet showing a number of applications and screen dump examples.

The calibration panel allows the user to test for the largest count rate envisaged during the course of a radioactivity experiment and thereby scale the Y-axis in suitable frequency units. There is also the facility to measure a background count which is automatically subtracted from subsequent count rates.

Program modes

The program has two principal modes of operation:

a) **count rate vs. time.** The user can select a time interval (1-100 s) over which, for example, a number of radioactive pulses are recorded and a count rate calculated. This rate is then displayed as large digits on screen. The recording process may be repeated 10-250 times and the final set of count rates displayed as a histogram (Fig.17), table or as large digits. Fig.17 shows the variation in background count rate over 25 20 s time periods. There is also the facility to automatically calculate the average count rate during the total period.

This mode is particularly suitable for the examination of radioactivity levels during half-life decay. Therefore it is possible to continuously monitor radioactive decay over total periods of up to 7 hours. Incidentally, pulses continue to be counted even when the computer is busy processing the calculation for the previous pulse rate.

b) **count rate vs. some other parameter.** In this mode the user specifies the number of pulses that are to be counted from the range 10-5000. The time it takes for these to arrive is measured by the computer, a count rate calculated, and the result displayed in large digits on screen. The recording process may be repeated 10-250 times with the computer waiting for a key-press from the user between each set of count rates.

When all sets of count rates have been captured they can be displayed as a histogram (Fig.18), table or as large digits. Fig.18 shows the count rates measured at 1-10 cm distance from a beta source. The software also allows the average count rate over all the readings to be calculated.

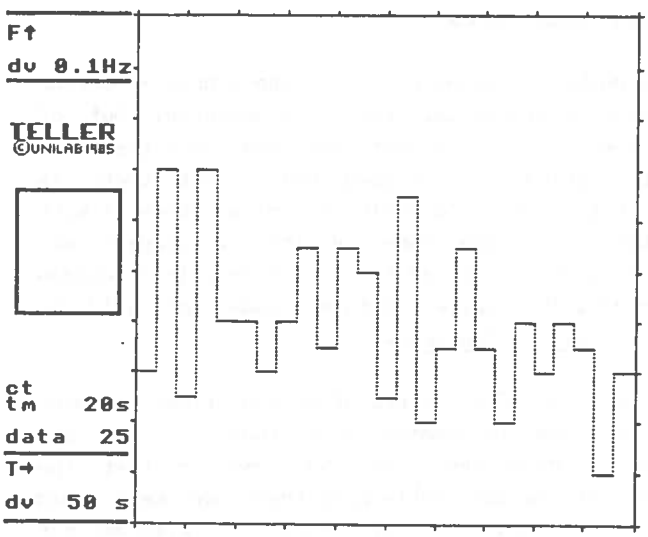

Fig.17

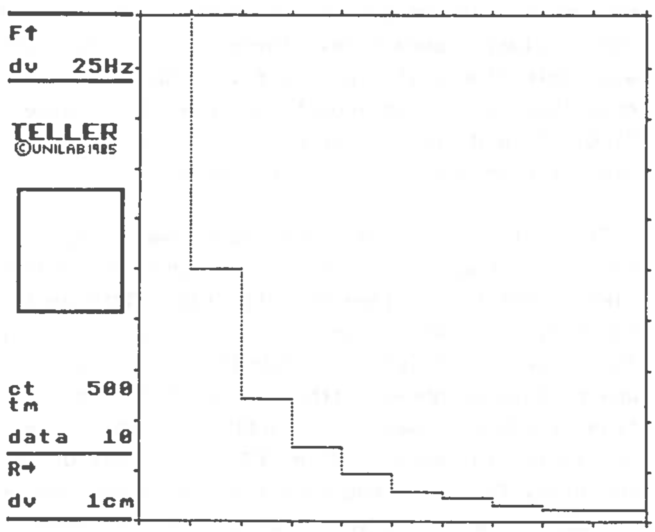

Fig.18

This mode can also be useful for examining how count rate varies with the thickness of an absorber placed in front of a radioactive source.

Concluding remarks

This is another program aimed at the physics department. Although primarily designed for radioactivity experiments it could find some applications in electronics for measuring frequency output from oscillator circuits.

* * * * *

TRADE NEWS

A proper degree of loopiness

In past articles on safety in microbiology we have recommended the use of metal chuck type holders in order that sterilisation by heat be properly effected. Recently we had a call from the Scottish area manager of Medical Wire. He pointed out that they were selling six and eight inch loop holders (Cat. Nos MW196/6" and MW196/8") at £3 and £3.50 respectively.

Also available from this firm are "microstreakers" (all right, all right - stop making up your own jokes!) which are combined wire and holder assemblies. Three loop sizes are available plus a straight wire. Loop sizes are described only semi-quantitatively as "large", "medium" and (you guessed it!) - "small". Microstreakers cost £4.90 per pack of 5.

Of course you can make your own loops by carefully bending nichrome wire around an object like a matchstick (see Bulletin 126). More useful for many applications are loops of known volume. These are much trickier to fabricate. Medical Wire again have an answer with a range of "microloops" from 1/100 ml down to 1/1000 ml. These are available in packs of 25 at £7.50 per pack of any one size. The only snag is a minimum order value of £25. However given that it lists a range of other useful items like autoclavable disposal bags, and paper strips for Grams test, the Medical and Wire literature is worthy of attention from schools.

Plastic pipe cutter

A patented hand tool for the neat and speedy cutting of all types of rubber and plastics tubing, including thin wall conduit, has been announced by Just Plastics. The cutter is claimed to handle tubing up to 38 mm i.d. and rod up to 15 mm i.d. depending on the exact nature of the material. It leaves a clean, square cut end eliminating the need for de-burring and ensuring "correct alignment when used with either compression or push fittings". Cat. No. 6200-001 at £9.95 per cutter.

"Standard Science Equipment"

Recently we had a rare visit, from a staff member of Ross and Lamont. This small firm makes and sells a model house for heat loss studies in the core topic "Energy" (see Bulletin 148 for a review). From the same stable came the materials tester we reviewed in Bulletin 142. Schools may be relieved to know that we were given a short catalogue with prices and more importantly, a telephone number. See the Address List on the inside cover of this bulletin.

Soil test kits

A number of schools have probably been wondering whither went the soil test folk Sudburys. Out of business is the answer. More precisely they went into liquidation. The good news is that there is another firm now offering a similar range of kits under the trade name 'Rapitest'. Readers may already have spotted these kits on sale in garden centres. The rapitest kits are made and sold by Wilson Grimes Products.

The list of directors of Wilson Grimes contains a few names in common with that for the old Sudbury directors. The bad news is that the similarities apparently stop there. We were told that the reagents for 'Rapitest' kits are not compatible with those for the Sudbury kits and thus cannot be used as refills for the latter. Wilson Grimes does not make or sell any direct replacements for Sudbury items.

* * * * *

Surplus Buying Agency, Woodbourne Road School, Woodbourn Road, Sheffield S9 3LQ.

Unilab Ltd., Clarendon Rd., Blackburn BB1 9TA. Tel. (0254) 57643.

Vela Users' Group, Dr. J.K. Jones, c/o Physics Dept., University of Leeds, Leeds LS2 9JT.

Wilson Grimes Products, London Road, Corwen, Clwyd LL21 0DR Tel. (0490) 2802 or 2804.

World Studies Teacher Training Centre, University of York, Heslington,
York YO1 5DD Tel. (0904) 59861 or 415157.

World Wildlife Fund, Education Department, Panda House, 11-13 Ockford Road, Godalming, Surrey GU7 1QU
Tel. (04868) 20551.

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