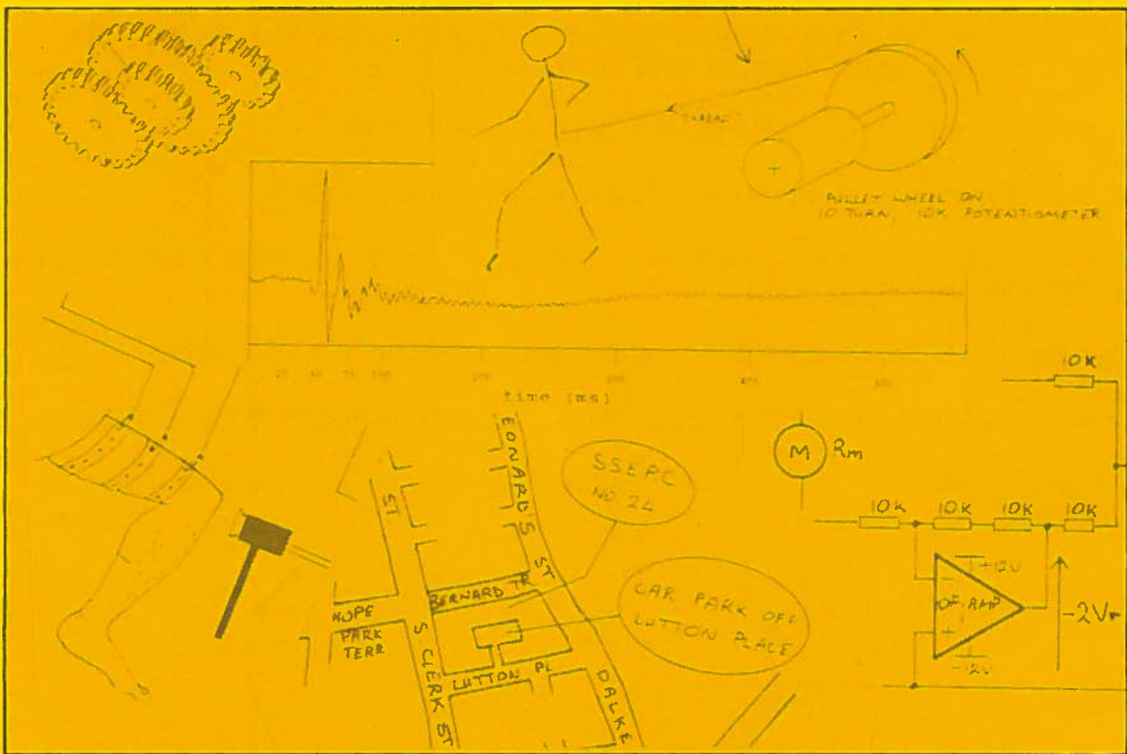
SCOTTISH SCHOOLS EQUIPMENT RESEARCH CENTRE



Science & Technology Bulletin

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The Centre is an independent national advisory service, solely controlled and largely financed by Scottish Regional and Islands Councils as Education Authorities. It currently incorporates the Science Equipment Research Centre and the Scottish TVEI Joint Support Activity Project :

STERAC (Science and Technology Equipment Research and Advisory Centre).

OPINION

Light gates are superseding the once ubiquitous ticker timers as the principle means of sensing movement in mechanics experiments. Their usage, with computers in particular, gives readings that are usually clear, clean, accurate and quickly obtained. By such means the laws of nature are laid bare. The tedium of analysing ticker tape and the bother of teasing out conclusions from poorish measurements are no more.

Most of us would agree that these are improvements over earlier methods. What is lost in the change is the ability to monitor movement continuously rather than take what is usually a single spot measurement. Therefore the advent of novel equipment which can fill this need is to be welcomed. Such equipment includes the Sonic Motion Sensor - an ultrasonic rangefinder linked to a computer (reviewed in "Equipment Notes" of this issue) - and video equipment comprising a camera with fast image capture, and a playback machine having a quality, still-frame facility. Both means can yield high quality measurements and are worth buying. And if you were to do so you would expect to raise the impression your pupils have of your subject through your, and their, usage of advanced rather than of old and simplistic apparatus.

But there is in our view still a need for elementary equipment as a foil and complement to the advanced. Such elementary equipment should have a construction and mode of operation readily understood by the pupils. It should also preferably be able to yield good quality measurements. This Bulletin contains examples of several simple, easily constructed and comprehended bits of apparatus. The movement sensors described herein - albeit linked to computers - can provide results every bit as good in their own way as their sophisticated, commercial cousins.

A couthy face is a friendly face. If all around is modern, plastic and hi-tech with what impression will we leave our pupils?

This may be the era of the black box, but black boxes need not and should not be allowed to wholly take over, or indeed dominate, apparatus.

* * *

Waffle, waffle

This is a big Bulletin. A lot has happened since last we went to press and we have a lot to tell readers and customers about general matters. We apologise therefore for the length of this introductory section - known to Centre staff as "the waffly bit". To counterbalance the weight of waffle we have a lot of meaty technical stuff to follow and can promise a deal more in future issues. But first.....

Bulletin distribution

This should now include Technical Education Departments through the relevant advisorate or directorate staff and TVEI personnel through the scheme co-ordinators. We have evidence from members of our Steering Group that few copies of Bulletin 162 successfully negotiated that carrier snail system. We suspect that internal school distribution systems were at fault and that the extra copies meant for technical teachers merely got sent to science along with the normal quota.

We have to trust that the dropping of the "Science" at the top of the cover and its inclusion with "Technology" at the bottom will help. We would much appreciate it if any P.T.s of Sciences who suddenly started getting an extra copy or copies would alert the school office staff and ask them to ensure that at least one copy goes to the Technical Education Department.

Change of Address

We moved into our new premises in two phases over late May and early June. Correspondence should therefore now be sent to our new address which is :

S.S.E.R.C.
24 Bernard Terrace
Edinburgh EH8 9NX

Overseas subscribers please add to that address "Scotland" or "U.K." (possibly both) but not - please not - "England"!

And of 'phone number

It was not possible for us to retain our telephone numbers since our new premises are in a different exchange area. You should therefore note our single new number :

031 668 4421

which accesses three lines in total. We hope it will not now prove so difficult to get through to us at busy times.

That last sentence reminds me to apologise to those who tried to 'phone us in May and June and particularly to those of you who share my near pathological loathing of the telephone answering machine. We were sorry to have to resort to the use of such a device. Had we not, then I think we might yet be in Broughton Street trying to pack boxes and tidy the place up.

All the same, given the Centre's tradition of assigning high priority to enquiries from individual teachers and technicians, we all felt guilty. It kept reminding me of the story of the young persons who had just landed jobs with a high street fashion retailer. Asked what they did they replied:

"Well, actually, we're Trainee Customer Ignorers".

Staff - 'Old' and 'New'

Who's who and what's what

We seem to have announced in dribs and drabs our various new appointments. It may therefore now be useful to readers to have a complete list of posts and postholders both old and new.

Calm yourselves, relax! No, there is no photographic gallery of grinning rogues set out in this issue. Nor will we provide tedious biographic details of when each was weaned, through to when they got their first tricycle and onward to their leaving full-time education, putting aside their ambitions on world travel or playing for one or other of the 'old' or 'new' firms and instead came, as an inspired choice, to work for this Centre.

That sort of stuff gets our goat as much as it probably does yours. We thought it might be more useful to set out as simply as possible who does what and thus indicate also probable first points of contact for assistance. I say "as simply as possible" because we work mostly as multi-disciplinary teams and that can cause complication. This at least has the advantage that if the first point of contact happens to be out then there may often be someone else who can at least understand the problem and sensibly take a message. So, here goes!

Who's who - staff team

Director :	John Richardson
Depute Director :	Allen Cochrane
Asst. Director :	Jim Jamieson
Administrator :	Anne White
Development Officer :	Ian J.Birrell
Technical Officer :	Ian G.Buchanan
Technicians :	
Sciences -	Marjorie Hamilton
Electronics -	Graeme Paterson

Specific JSA Project Staff

Senior Proj. Officers :	
Technology Education :	Danny Burns
Information Technol. :	Clive Semmens
Secret. Assistant :	Margaret O'Malley
Project Officer :	Derek McLaughlan
Appl.Science Tech'n :	Robert Little

(Technology Equipment Technician - appt.pending)

Table 1.

Who's what

The Centre is organised and managed using what the jargonists would no doubt call "a matrix model". This is a fancy way of saying that, as well as their specialist workloads, several staff have general responsibilities across the Centre's activities. From the point of view of teacher, technician or advisorate client it would perhaps be useful to spell out plainly who are the staff best first approached on specific problems with equipment, safety or resources for particular courses or curricular areas. This we attempt in Tables 2 and 3.

Subject specialisms

Note that subject specialisms are merely in alphabetical order - no hierarchy is intended. To save space, initials are used to denote relevant staff. Common sense referral to Table 1 under "Who's who" should remove any doubt e.g. IJB is Ian J.Birrell and IGB Ian G.Buchanan. Emboldened initials emphasise first line contacts.

SUBJECT	STAFF 1st contact	Back-up	NOTES
Biology	**DMc**	JR	Safety - **JR**
Chemistry	**AC**	IJB	Safety - **AC**
Physics	**JJ**	CS or IJB	Safety inc.ionising radiation **JJ**
Technol. Studies	**DB**	IGB	Also Craft & Design, Tech. Drawing etc.

Table 2.

Other specialisms

As well as their experience of teaching or supporting certain subjects, staff also have technical expertise or operational responsibilities cutting across subject boundaries. A number of such specialist areas are tabulated in Table 3 overleaf.

AREA	STAFF 1st contact	Back-up	NOTES
Electrical Safety	**JR**	AC,JJ	
COSHH :	**AC**	JR	
Electronics:			
	JJ	CS	In physics
	CS	JJ	Short Courses
	DB	CS	Tech.Studies
	GP	JJ,CS	Construction techniques
Information technologies	In context of science & technology <u>only</u>.		
Datalogging and Control	**IJB**	DMcL	EMU & VELA
	JJ	IJB	Unilab Grapher Unicos,djb etc.
Software Engineeering	**CS**	DB	New applications in data logging & control.
Databases	**IJB**	MH,DMcL	For equipment lists etc.
	CS	IJB	New applications

Table 3.

Policy, goods and services

General enquiries on Centre activities, work and training programmes, accidents or incidents related to health and safety issues or other policy matters should be addressed in the first instance to the Director.

For enquiries on subscriptions, the supply of SSERC publications or on paperwork received with such publications or with sales goods then please first enquire of Anne White or Margaret O'Malley. Technical queries on SSERC goods are best dealt with by Ian Buchanan or Graeme Paterson.

* *

Saturday opening

We are getting sufficiently settled in the new premises to begin thinking about again opening on Saturday mornings. Our official inauguration ceremony in September will delay things but we intend re-starting on the first two Saturdays of October, November and December. We will be open, as before, from 9.00h to 13.00h. On the inside back cover is a map with the location of the new centre.

We will then review the pattern of visits by teachers and technicians with a view to either ending the scheme or extending it to every Saturday, barring school holiday periods.

* *

Technological Studies

Regular readers will note that the introductory article on this subject (on pages 8-19 of this issue) goes well beyond the equipment related, technical resource support which we normally offer for curriculum development.

Why the change in approach? In addition to our traditional role on equipment and practical work for science (and now, formally, technology) - the SSERC function - we have an added Joint Support Activity (JSA) function - the STERAC function - of helping schools start up in new curricular areas such as Technological Studies. It is almost impossible for us to give advice on resourcing such new courses without stating clearly at the outset how we see the coursework, and particularly project based activity, being organised and taught. The JSA provides that wider remit.

The leopard has not lost or changed any spots but merely, for the duration of the JSA project, gained a few.

* * *

Soldering - what precautions to take

The Centre has been asked by teachers, who earlier this year attended the national launch course on Electronics Short Courses, to give advice on what precautions to take in soldering. The advice which follows is pertinent to both staff and pupils.

1. Risk of high voltage shock

There is a foreseeable risk that the tip or shank of a hot iron may touch and melt through the insulation of a mains cord and make contact with the live conductor therein. There are several means of minimizing this risk.

a. Usage of an isolated, low voltage iron (24 V is the standard, low voltage rating).

b. Usage of heat resisting silicone cable for the cord.

c. Provision and usage of a bench holder, which is a stand for the safe placement of a hot iron not in use.

d. Provision of residual current circuit breaker (RCCB) protection in the laboratory or workshop.

e. Implementation of a programme of routine, regular, safety checks on all portable mains equipment, including soldering irons and their LT supplies if any.

f. Judicious layout of mains cords between the socket outlets and appliances on the workbench.

The provision of either **a.** or **b.** is essential and the combination of both **a.** and **b.** is strongly recommended. Note that from an operational as distinct from a safety reason the provision of **b.** is strongly recommended. If heat resisting cords are not used then heat damage will inevitably occur, knocking equipment out of action.

The provision of **c.** is essential, and **d.** is highly recommended. The carrying out of **e.** is a requirement of the Health and Safety Executive (under GS23), and is essential.

Relating to **f.**, socket outlets should preferably be sited at the back of workbenches so that flexible cords run to appliances from the back (Fig.1a), not trail across benchtops from the front (Fig.1b). If it is necessary to use this latter configuration cords should either be (1) replaced with heat resisting silicone cable, or (2) sheathed in heat resisting p.t.f.e. or glass fibre sleeving. (1) is preferable to (2) since sleeving renders cords inflexible, and glass fibre can irritate sensitive skins.

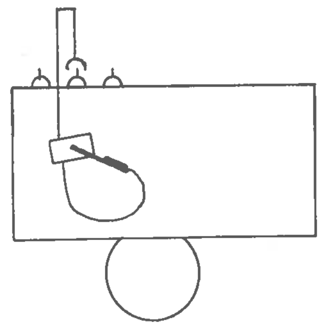


Fig.1a - Good layout of mains cords

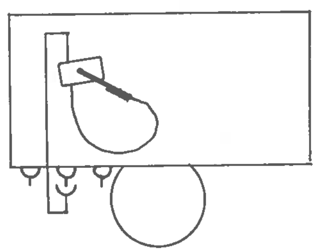


Fig.1b - Poor layout of mains cords

Be particularly careful of cord routeing if more than one mains appliance is in use on a bench at any one time. This may happen if a circuit is being repaired at the test or modification stage when power supplies, oscilloscopes and other test instruments as well as a hot iron might all be powered up.

The usage of cordless irons is not recommended for operational reasons.

2. Risk of skin burns

The provision and usage of a bench stand is the means of minimizing this risk.

Pupils should be given basic first aid instruction on how to deal with skin burns:

> Generally the damaged part should be flushed with cold running water immediately after the burn happens. This action should be continued until the pain goes away, which may take up to 10 minutes. The speed with which treatment starts does seem to be important in helping to relieve subsequent pain. Injuries seem to heal better if treatment starts 5 s rather than 1 min after infliction. Medical assistance should be sought if further treatment were to be required.

3. Risk to eyes

There is a small but foreseeable risk of injury to eyes, which can be minimized by the wearing of eye protection. There are several distinct risks: (1) burns, through contact with a hot iron; (2) the sputtering of hot flux, which may hit the cornea; (3) the shaking of hot solder off irons; and (4), a related topic, the projection of snipped wire ends or component leads.

We know of no instance of the first risk (1) ever having occurred. The second (2) occurs infrequently to our own technicians. It can be momentarily painful, but does not appear to cause damage.

Soldering is an intricate job which requires focusing with concentration on objects near to the face. The wearing of inappropriate eye protection such as goggles could impair vision. Some form of safety spectacles would therefore be more suited to protect against such risks. Persons who normally wear spectacles may not require any additional form of protection.

The level of lighting on the workbench should be sufficiently good so as not to discourage the wearing of eye protection (and to support a high standard of work).

4. Risk of ingestion of heavy metals and other toxic substances

In soldering (and in other forms of electronic construction) workbenches become littered with debris: droplets of frozen solder, snippets of wire and insulation, dust from abraded solder or wire, etc. There is a risk of harm caused by the accidental ingestion of part of this dross. This can either directly happen going from benchtop by hand to mouth, or indirectly through various routes - perhaps via clothing, or food, or combinations of factors. Other persons using the working area, possibly long afterwards, can also be at risk.

Means of minimizing the risk include:

a. Cleaning workbenches at the end of each lesson (for pupils), or day (for staff). Cleaning should include both sweeping clean (into a dustpan), and wiping clean with a damp disposable towel thereafter. Cleaning operations should be conducted so as not to spread the contamination but to dispose of it.

b. Washing hands after benchwork. If practical work is interrupted by a meal or tea break then hands must be washed prior to the break.

c. Not eating at the workbench.

d. Brushing clothes after work.

It may be desirable to cover part of the workbench with some form of tidy-mat, which can be lifted off once soldering and other construction operations are over.

It should be noted that the Health and Safety Executive rate the risk of harm from ingestion of toxic materials second in order of magnitude to all risks from soldering. The risk of electric shock comes first.

5. Risk of inhalation of fumes

Fumes produced during soldering are unquestionably unhealthy. Ways of limiting risk include :

a. Avoid inhaling them.

b. Ensure that the work area is kept well ventilated.

The use of a fume absorber or extractor adjacent to the iron is not recommended since the frequency of usage is unlikely to be sufficiently high to warrant this. It may however be that the room itself requires powered ventilation. This would depend on numbers likely to be soldering, the room volume, natural air changes from draughts, etc.

6. Standing at work

This point is not directly related to safety. Many teachers have a general ruling that pupils must be standing if doing practical work. There are fairly good reasons why this ruling is made. However we recommend this should not apply to pupils who are soldering. The delicate manipulations which are required are better carried out whilst seated.

Checklist

The following is the list of provisions which the school must make (the references relate to the text above): **1a** or **1b** **1c** **2** **3** **5b**. Implicit in this advice is the requirement for the provision of washing facilities in or adjacent to any room which is to be used regularly for soldering.

These further provisions are strongly recommended: **1a** and **1b** **1d**.

The implementation of **1e** is essential.

The following summarize good practice in which teachers must train their pupils:

1c 1f 2 3 4a 4b 4c 4d 5a.

Further advice on soldering

General and specific advice on soldering practice, including safety matters, and the equipment required is to be found in SSSERC Memo 1, "Constructional Techniques", 1984, copies of which are available from SSERC, price £1.50.

The Centre is currently evaluating equipment required for soldering and intends to publish advice thereon in a future bulletin.

* *

Bursting bottle experiment

Griffin have written to us asking that we publicize the risk that can be encountered, through not following safety instructions, when using a Bursting Bottle (XHL-300-Y). This apparatus gives a dramatic demonstration of the anomalous expansion behaviour of water freezing. It consists of a cast iron bottle with a tapered thread to take a square-shanked iron stopper.

In usage the bottle should be filled with distilled water and the stopper inserted and tightened using a spanner or similar tool. The bottle should then be placed in a shatterproof container such as a polypropylene beaker, and a mixture of ice and salt packed around taking care that the bottle remains UPRIGHT. Some two minutes later a loud crack should be heard indicating that the bottle has shattered.

Sometimes small fragments fly off with enough force to cause injury. It is therefore necessary that a safety screen is used and that persons watching stand a reasonable distance back.

These safety procedures are given in the instructions which the manufacturers supply with the bottle. What concerns them now is that there is evidence that some teachers are not following this safety advice. If the advice is complied with there would not seem to be any significant risk of harm.

* *

Iodine filter for infrared

We have had an enquiry on iodine filters for infrared radiation. The traditional recipe is a suspension of iodine in carbon tetrachloride, which solvent is a suspected carcinogen. A less hazardous substitute is 1-1-1 trichloroethane.

If iodine is added to this substitute the colour turns a deep red. A test-tube width is almost opaque to visible light, but transmits infrared radiation.

* * * * *

SSERC AND TECHNOLOGICAL STUDIES

Introduction

Teachers tackling Technological Studies for the first time must have many questions on their minds. I know that I did. In fact I remember wading through the material from the Scottish Examination Board (SEB) and the starter and exemplar materials from the Scottish Consultative Council on the Curriculum (SCCC) and thinking that what was needed on the front cover of all this material was the legend **"DON'T PANIC"** and, as in the Hitch Hiker's Guide to the Galaxy, these words should be in bright bold colours.

I didn't panic but I still had a lot of questions on my mind. Questions such as:

1. Does the school have sufficient resources?

2. Does the school have appropriate accommodation?

3. Do I have enough course material?

4. How do I cope with a mixed ability class of twenty?

5. Do I have enough personal knowledge and understanding?

6. How can I integrate the different areas of study?

We hope that we at SSERC can assist teachers by offering advice in all of these areas and through a series of articles in subsequent bulletins, provide useful technical support and some relevant resources.

Problem Solving

Clearly stated in the SCCC Guidelines on Course Development is that:

"Technological Studies requires problems to be solved through the application of the systems approach which concentrates on using technological devices to solve problems through a working knowledge of their function. A knowledge of the internal workings of a device is not considered essential in order to operate or use it effectively."

Reading further (Appendix 4) it becomes clear that the Top Down Design Process, linked with a Systems Approach, is fundamental to the Standard Grade course. Not only is it the process by which pupils are to solve practical problems but it is also the vehicle upon which the other course learning outcomes, knowledge and understanding and technological communication, are to be carried. A solid conceptual understanding of the Top Down Design Process and of the Systems Approach is therefore essential. The remainder of this article looks at these concepts in detail.

What is the top down systems approach?

Teachers who have taught Craft and Design should be familiar with the top down design process whereby a need is recognised, a clear goal set and a design process model followed.

For pupils this puts the learning material into **context** providing them with a focus to aid their intellectual development.

For the teacher, this design process allows **differentiation** of course materials, with the more able pupil providing the more complicated solution.

The **systems approach** is a concept perhaps more difficult to appreciate. It is thought by many to have been a response to the need for a more formal approach to the design of engineering artefacts, which became apparent during the Second World War, in order to develop advanced weapon systems.

To the technologist a system is simply a collection of components which interact to perform an overall function that can be described in terms of inputs and outputs.

This simple idea of a system can provide a powerful problem solving method whereby the systems objectives (i.e. inputs and outputs) are specified **first** and the means of achieving them considered, independently, later.

This is **Top Down Design** and is a tool greatly used in industry since it allows the problem to be modelled in a number of ways, e.g. a mathematical model, a scale model, or a computer simulation, in order that the final 'real' system meets the required specifications before construction begins.

There is however another systems approach. Here one starts by considering actual components and systems, investigating their properties and arriving at a system specification. Consequently a system can be seen as a resource and used as a building block to produce technological artefacts. This approach often leads to a patchwork solution rather like putting the cart before the horse with the resources dictating the problem.

This is **Bottom Up Design** and although it is sometimes used in industry, it is not the approach recommended by the SEB. It lacks structure, provides little context and makes integration difficult. This "systems approach" should therefore be avoided in Standard Grade Technological Studies.

Classroom Implications

In contrast the top down systems approach does give the pupil a structure and a way of thinking which is transferable to other problems, not solely the technological. It also allows pupils to work at a level appropriate to their ability.

For teachers this approach allows work at a level at which they are happy and enables their own knowledge and understanding to develop as the course proceeds. It is worth re-emphasis that this methodology also allows the teacher to use the same project for pupils of different ability levels. It also actively promotes integration of the areas of study.

The Systems Approach in Action

The top down systems approach then is not solely restricted to technological problems. To illustrate the point I shall show how such an approach can be used as an aid to course construction for Standard Grade Technological Studies. In other words I shall determine the requirements of the course in terms of inputs and outputs **before** considering the means of achieving the course goals.

Figure 1 represents the Standard Grade Technological Studies course as a single system with the control feedback loops of moderation and evaluation. "Zooming in" on this system produces Figure 2 which shows identifiable subsystems (the introductory and main units) each with its own specifications or learning outcomes. What needs to be remembered is that the specifications of the individual subsystems must, together, fulfil the requirements of the course i.e. that they satisfy the aims and objectives of the Standard Grade Technological Studies course.

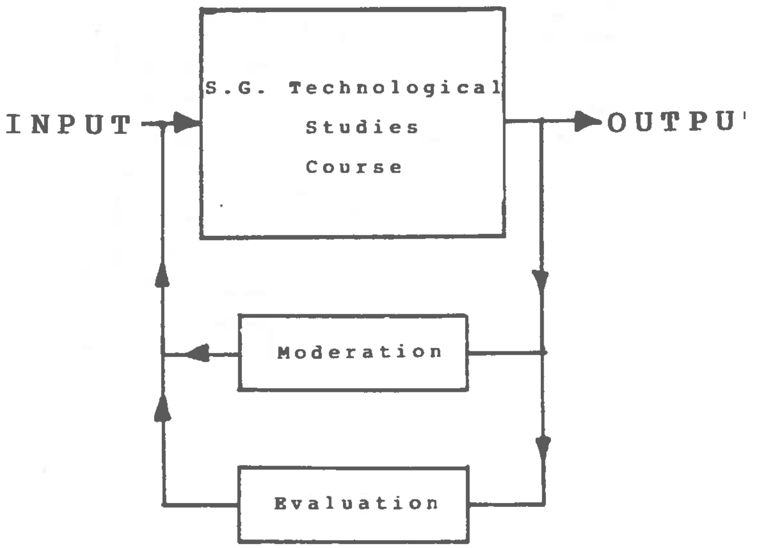
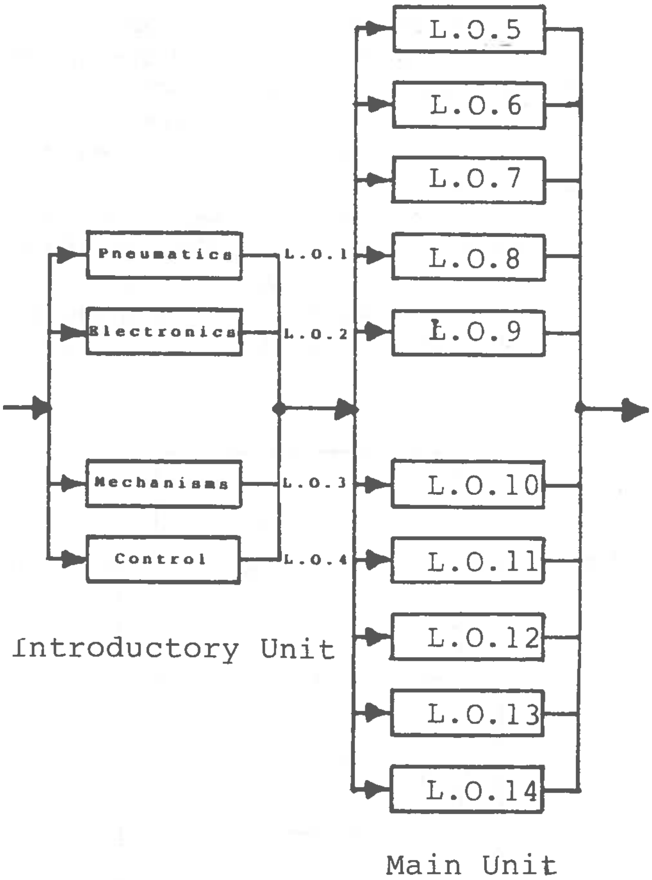


Fig.1

In figure 1 the system boundaries are chosen so as to include moderation, done at a local level and evaluation, done at national level. The **input** to the system will be a class of up to twenty mixed ability pupils and the **output** from the system is that same group of pupils, each pupil having developed aspects of awareness and understanding of technology as stated in the course aims and objectives.

In figure 2 the system boundaries are narrowed and more detail given. The Introductory Unit, where pupils are exposed to the different areas of study separately with little integration is shown along with the Main Unit, where ten projects are designed around the required learning outcomes.



COURSE WORK

Fig.2

With the course represented as a collection of subsystems each having specific learning outcomes I can now select a subsystem from the Main Unit and provide an example of achieving the required learning outcomes. I have decided to concentrate on the Main Unit since a great deal of effort has been expended, much of it duplication, on the Introductory Unit by others.

Using the top down design process we can:

1. state the learning outcomes.
2. state the content to be covered.
3. select a project to provide a context for learning.
4. provide a resource file to guide pupils' learning experiences.
5. ensure that the project can be tackled at different academic levels.

Figures 3 through to 10 illustrate such an approach. These figures are slightly reduced versions of real course materials. They provide examples of project brief, resource file sheets, pupil diary page and assessment records.

Summary

It should be noted that a system is always a concept and never merely an artefact or piece of equipment. Although there may be more than one systems approach there is only one top down systems approach. As a method of problem solving this approach encourages structured thinking rather than just a way of assembling pre-built subsystems. Unfortunately, the latter may still be all too common in technology education departments.

cont./figs.3-10.

PROJECT TITLE : CONVEYOR BELT SYSTEM

PROBLEM : To design and build a conveyor belt system which transports materials at a given rate, removes oversize components and then counts the number reaching the end of the system.

LEARNING OUTCOMES : The pupil should be able to :

1. select appropriate mechanisms.
2. select appropriate electronic subsystems.
3. use the systems approach to problem solving.
4. write a short technical report.

CONTENT/ CONTEXT : To provide a solution to this problem the pupil will need to investigate a number of mechanisms, electronic systems and perhaps pneumatic systems and hence become familiar with the following:

MECHANISMS

simple gear train, compound gear train, couplings, support bearings.

ELECTRONICS

counters, AND gate, transducer driver, solenoid unit relay unit, delay unit.

PNEUMATICS

single acting cylinders, solenoid valves.

INTEGRATION

the interfacing of mechanical / electronic / pneumatic systems.

Fig.3: the expected learning outcomes.

PROJECT No.19 : A CONVEYOR BELT SYSTEM

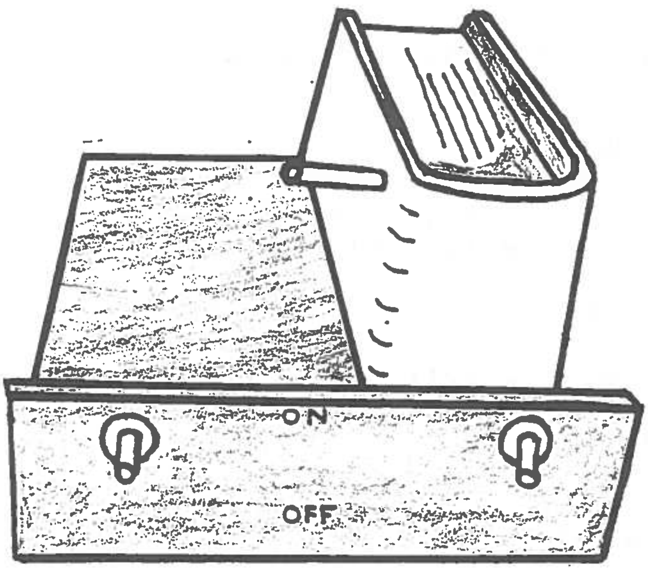
A manufacturer is establishing a new factory in your area.

As part of their overall strategy the owners would like this factory to be as efficient as possible and from previous experience they recognise that the method of transporting materials within the factory has a great effect upon efficiency.

After much consideration it has been decided to install a conveyor belt system as the final stage of the manufacturing process and that this system must satisfy the following specifications :-

1. The speed of the belt must be less than 50 mm / s .
2. Two master switches must be used to switch the system ON. (for operator safety)
3. Oversize products must be DETECTED and REMOVED from the system.
4. The number of products reaching the end of the system must be recorded.

<u>You have been given the responsibility for the development of this system.</u>



You may use any of the Resources with which you are familiar.

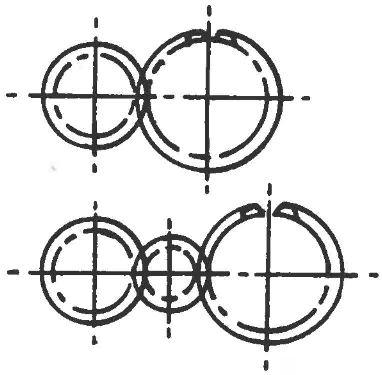
In addition you should study the material in RESOURCE SHEETS 10 & 11 as this may help you in providing a solution.

Fig.4: the project brief which gives the context.

Mechanisms

RESOURCE SHEET No.10

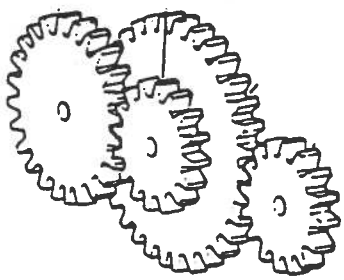
1. Simple Gear Train



Clockwise Motion → SPEED CHANGE → ANTI Clockwise Motion

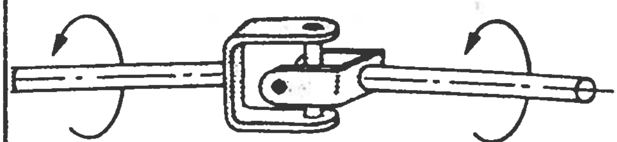
Clockwise Motion → SPEED CHANGE → Clockwise Motion

2. Compound Gear Train



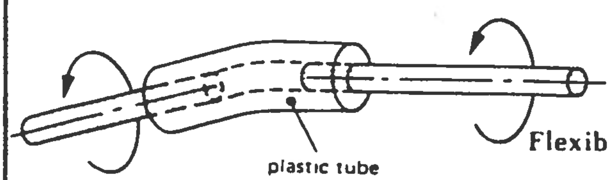
Clockwise Motion → LARGE SPEED CHANGE → Clockwise Motion

3. Couplings



Universal joint

Rotational Motion → small CHANGE OF AXIS → Rotational Motion



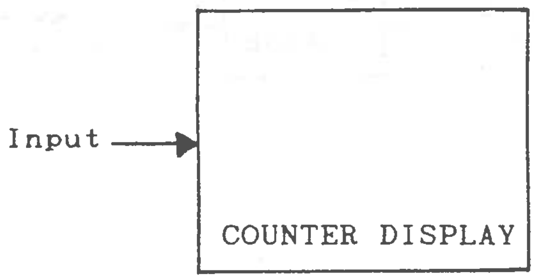
Flexible coupling

Fig.5: part 1 of the resource file.

RESOURCE SHEET No.11

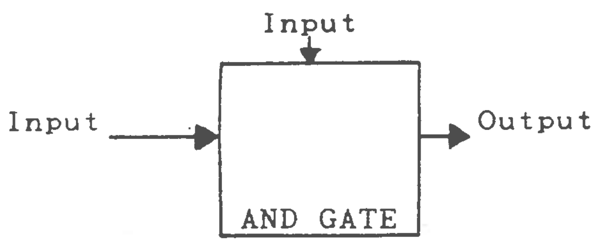
Electronic Sub-systems

1. The Counter Display



This unit will count the number of PULSES occurring at its INPUT. (A pulse is a signal which goes from LOW to HIGH to LOW again or vice versa)

2. The AND Gate



This LOGIC gate will only OUTPUT a signal when BOTH INPUTS are HIGH as shown in the truth table below.

A	B	Z
0	0	0
0	1	0
1	0	0
1	1	1

Fig.6: part 2 of the resource file.

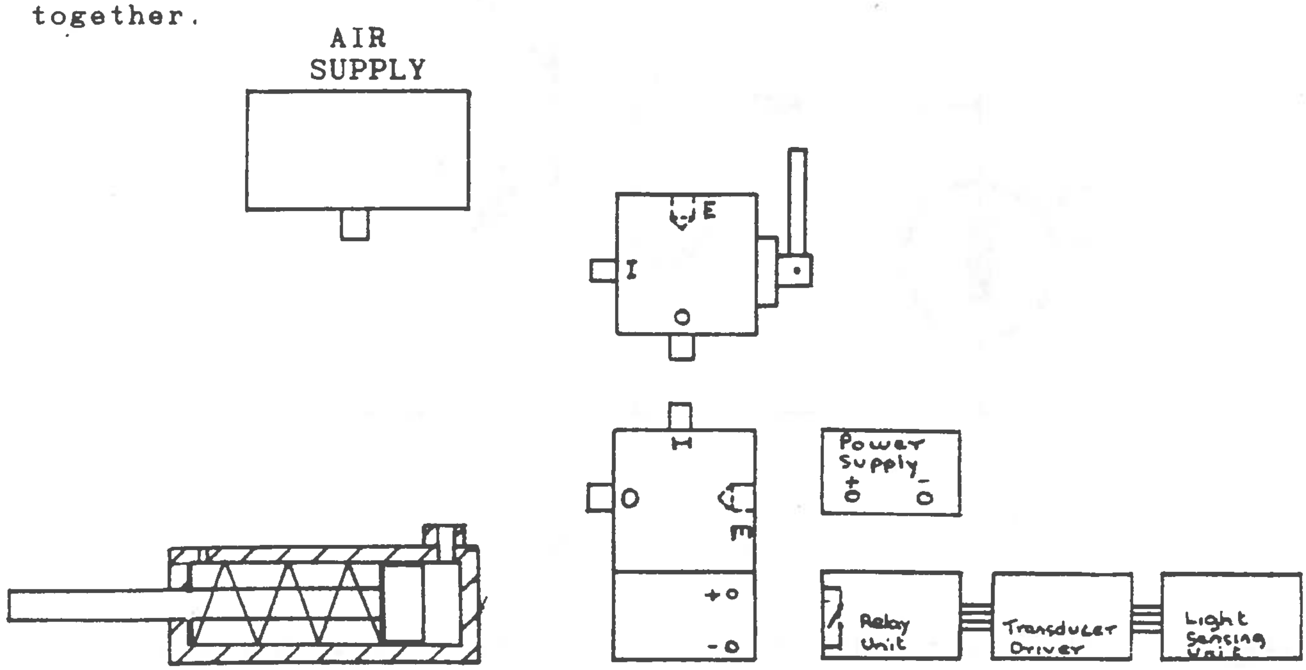
WORKSHEET No.18 : THE CLAMP Pt.1

Using the components shown below allows us to use an electronic system to control a pneumatic one.

This is increasingly the case in industry.

Connect up the pneumatic circuit as you have done previously in worksheets 16 and 17.

Now connect the 12 Volt Supply, Relay unit and soleniod valve together.



The unit which joins (interfaces) the two systems together is called the :- . ______________________________ .

By refering to the systems diagram below explain how the system works.

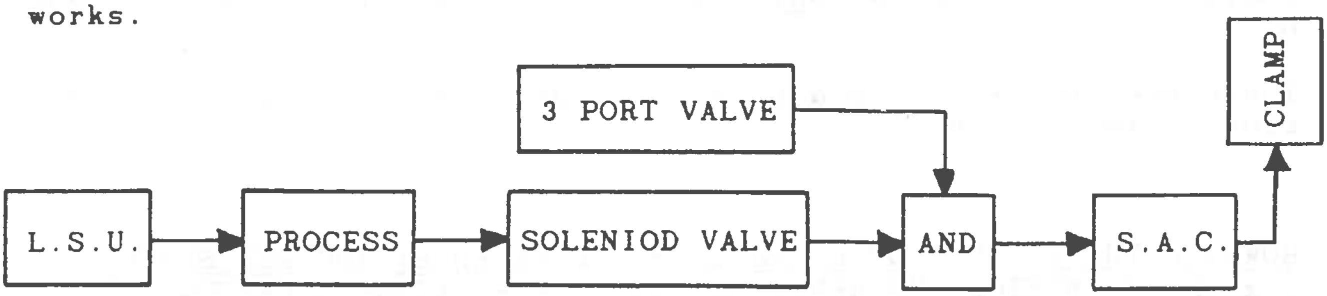
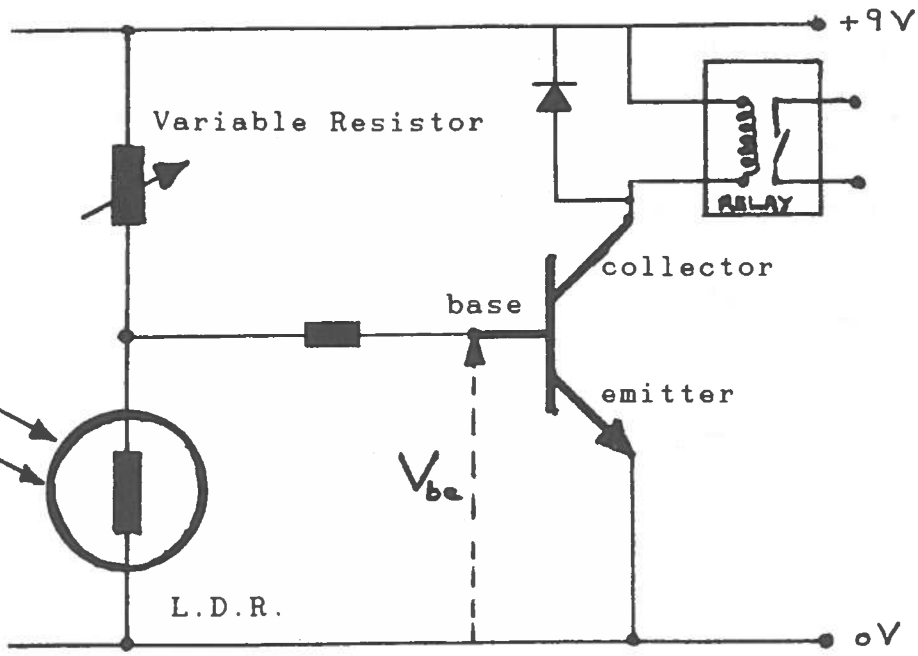


Fig.7: part 3 of the resource file. This refers to earlier work.

THE TRANSISTOR SWITCH



DESCRIPTION

The transistor switch is controlled by the VOLTAGE DIVIDER :

Variable Resistor / Light Dependent Resistor

The transistor will allow a large current to flow from the POSITIVE RAIL to GROUND <u>only</u> when the voltage V_{be} is larger than 0.6 volts.

Therefore this would be a Light Dependant Switch which would only conduct in darkness.

<u>HOWEVER THE L.D.R. COULD EASILY BE REPLACED BY ANOTHER SENSOR e.g. A THERMISTOR AND HENCE BECOME A TEMPERATURE DEPENDENT SWITCH.</u>

Fig.8: extension material for the more able pupil.

STRIPBOARD LAYOUT SHEET

TRANSISTOR SWITCH

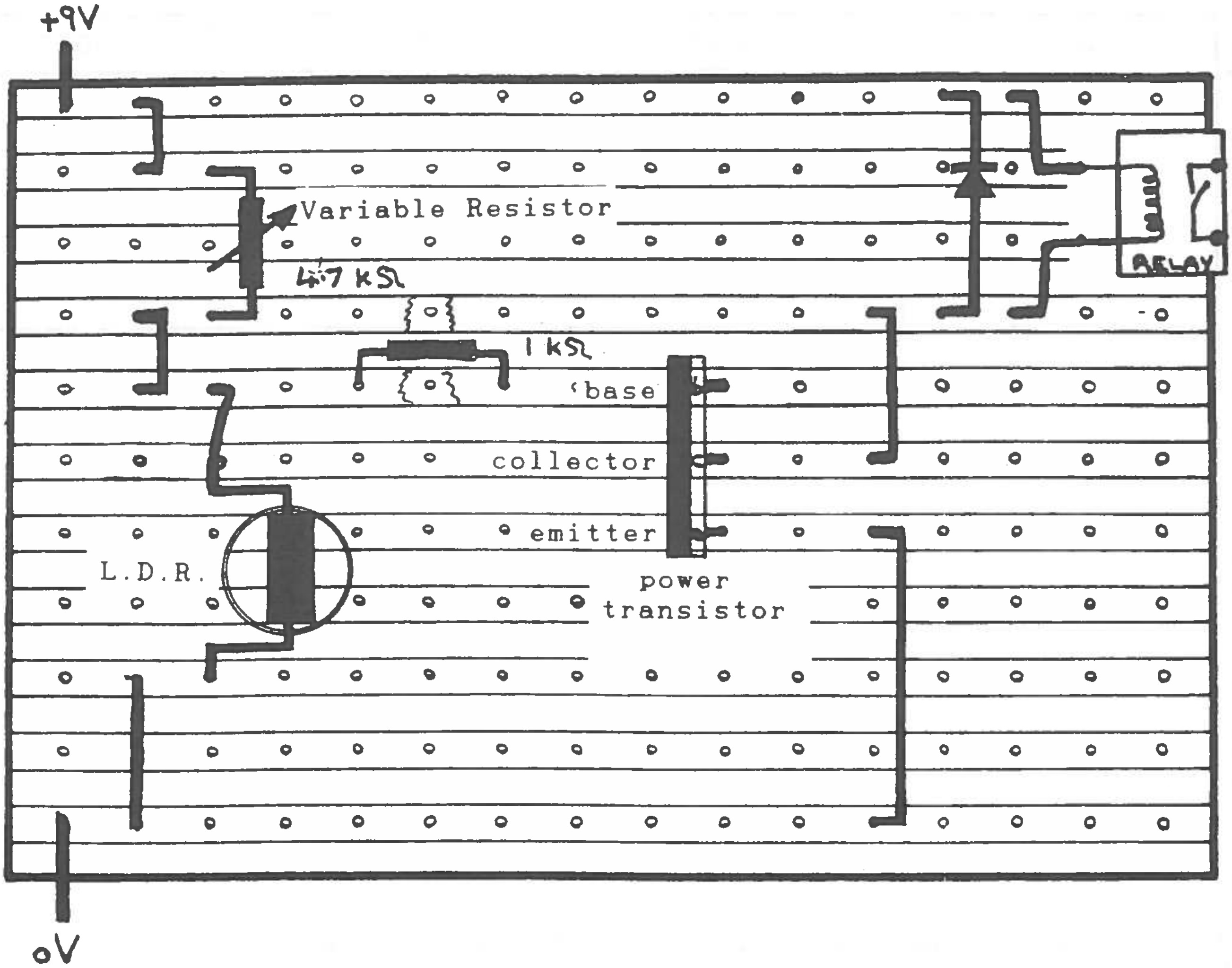


Fig.9: construction diagram for the extension material.

DIARY OF WORK

PROJECT TITLE : ______________________________________.

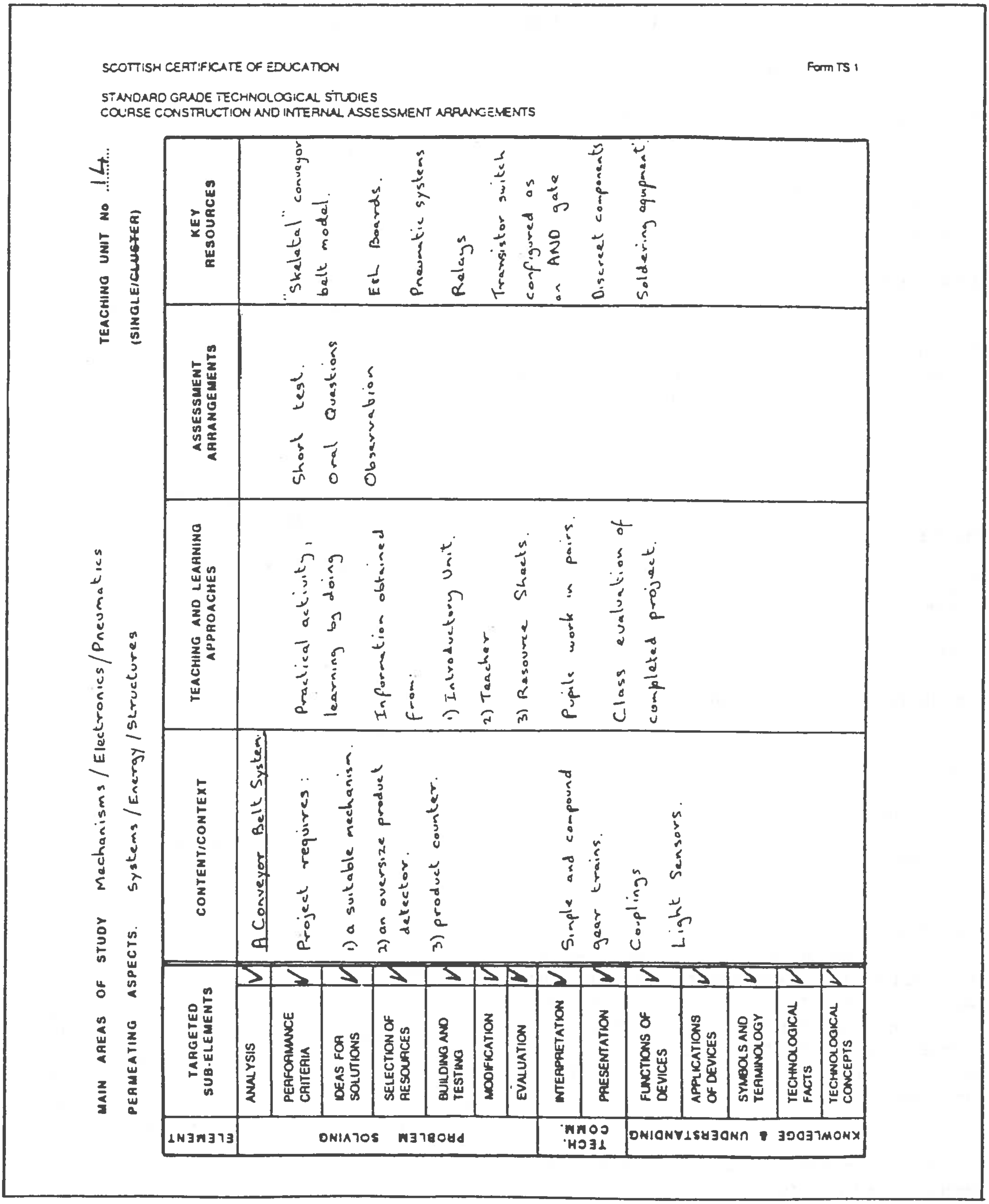
DATE STARTED : ________________________.

DAY	SUMMARY OF WORK DONE	CHECKED

When attempting any project you should be involved in the following activities :

1. Representing the problem as a SYSTEM with an input and an outp
2. Stating what a system should do i.e. STATE SPECIFICATIONS.
3. Investigating a variety of solutions.
4. Selecting RESOURCES i.e. items of equipment.
5. Building and Testing models.
6. Modifying your solution. Perhaps to improve it.
7. Evaluating the success or failure of your solution.

Fig.10: pupils diary of work.



SCOTTISH CERTIFICATE OF EDUCATION — Form TS 1

STANDARD GRADE TECHNOLOGICAL STUDIES
COURSE CONSTRUCTION AND INTERNAL ASSESSMENT ARRANGEMENTS

MAIN AREAS OF STUDY Mechanisms / Electronics / Pneumatics

PERMEATING ASPECTS. Systems / Energy / Structures

TEACHING UNIT No 14

(SINGLE/~~CLUSTER~~)

ELEMENT	TARGETED SUB-ELEMENTS		CONTENT/CONTEXT	TEACHING AND LEARNING APPROACHES	ASSESSMENT ARRANGEMENTS	KEY RESOURCES
PROBLEM SOLVING	ANALYSIS	✓	A Conveyor Belt System. Project requires: 1) a suitable mechanism. 2) an oversize product detector. 3) product counter. Simple and compound gear trains. Couplings Light Sensors.	Practical activity, learning by doing Information obtained from: 1) Introductory Unit. 2) Teacher 3) Resource Sheets. Pupils work in pairs. Class evaluation of completed project.	Short test. Oral Questions Observation	"Skeletal" conveyor belt model. E&L Boards. Pneumatic systems Relays Transistor switch configured as an AND gate Discreet components Soldering equipment
	PERFORMANCE CRITERIA	✓				
	IDEAS FOR SOLUTIONS	✓				
	SELECTION OF RESOURCES	✓				
	BUILDING AND TESTING	✓				
	MODIFICATION	✓				
	EVALUATION	✓				
TECH. COMM.	INTERPRETATION	✓				
	PRESENTATION	✓				
KNOWLEDGE & UNDERSTANDING	FUNCTIONS OF DEVICES	✓				
	APPLICATIONS OF DEVICES	✓				
	SYMBOLS AND TERMINOLOGY	✓				
	TECHNOLOGICAL FACTS	✓				
	TECHNOLOGICAL CONCEPTS	✓				

Fig.11: the S.E.B. guidelines for course moderation.

Reflex action

Abstract

A method for estimating the latency period of a reflex action is described. Hints on the construction of a hammer with a built-in triggering mechanism are given.

Introduction

Both Standard Grade Biology Topic 5 and the CSYS Behaviour topic require some understanding by students of the action of a reflex arc. With the increasing availability of specialist equipment in school science departments it is now possible to demonstrate the electrical activity associated with reflex responses and to obtain quantitative estimates of latency.

Background theory

The stretch reflex - the simplest spinal reflex is a monosynaptic reflex which only involves two neurones and one synapse. The knee jerk is of this type. Refer to Green [1] for more information.

Technical considerations

Biological amplifier - for safety and practical reasons a particular kind of biological amplifier is used in these experiments. It must have opto-isolation. For further details on safety in electronic measurement in human physiology refer to SSSERC Bulletin 145.

As well as providing opto-isolation, the amplifier must be of the differential type, where three electrodes are used. Such an amplifier will only amplify differences between two of the inputs with respect to a third. It will ignore any steady d.c. component, noise from mains pick-up or from another source in the body other than that selected for by the geometry of the electrode arrangement.

The Unilab Biological Amplifier 743.001 £84.20 meets the above criteria.

Display options

The signal output from the amplifier can in theory be processed and displayed in a number of ways.

- directly on an oscilloscope
- recorded on audio tape and played back to an oscilloscope or computer interface
- interfaced to a computer
- stored in a datalogger and displayed on an oscilloscope
- downloaded from a datalogger to a computer and thence to a printer

Practical methods

Largely for technical reasons these possibilities currently are reduced to the last two datalogger based procedures as the preferred working arrangements. The other methods all suffer from a variety of snags which include fleeting displays, signal degradation, difficulties in triggering the onset of data capture and lack of the required printout for ease of measurement.

There are ways around most of these problems. We would be pleased to assist anyone wishing to use other methods and equipment. Examples include displaying the signal on a storage oscilloscope or direct logging on an intermediate interface with a fast A-D facility such as the Unilab Interface with 'Grapher' or 'Uniscope' software.

For relative brevity we give in detail only two trialled procedures. Both of these use a datalogger. The first is simply for a demonstration of the pattern of electrical signals from a reflex arc. The second extends the method to provide estimates of the latency period.

Equipment required

For a qualitative demonstration:

Unilab Biological Amplifier 743.001
tendon hammer (DIY) for triggering
datalogger (VELA)
oscilloscope

Additionally for measurement of latency:

BBC Computer
Philip Harris 'Datadisc' or 'Datadisc +' software
dot-matrix printer

Qualitative demonstration

The amplifier output is first logged on a datalogger (VELA). The rate of data capture in VELA is high, resulting in a clean final output signal. Logged data can then be displayed on an oscilloscope quickly and easily.

If a display on a monitor or a hard copy of the results is needed the recording can be checked on the oscilloscope before downloading to the computer.

Quantitative work

Once the data has been downloaded into the computer with suitable software and dot-matrix printer a printout can be obtained and the latency period estimated. Accurate determination of latency is difficult from either the oscilloscope or monitor screen hence the likely need for a printout which may also provide a table of results.

Why not EMU?

We know that a lot of Scottish schools have recently acquired Harris EMU (Easy Memory Unit) dataloggers. At present the use of EMU as a substitute for VELA in this experiment is not feasible.

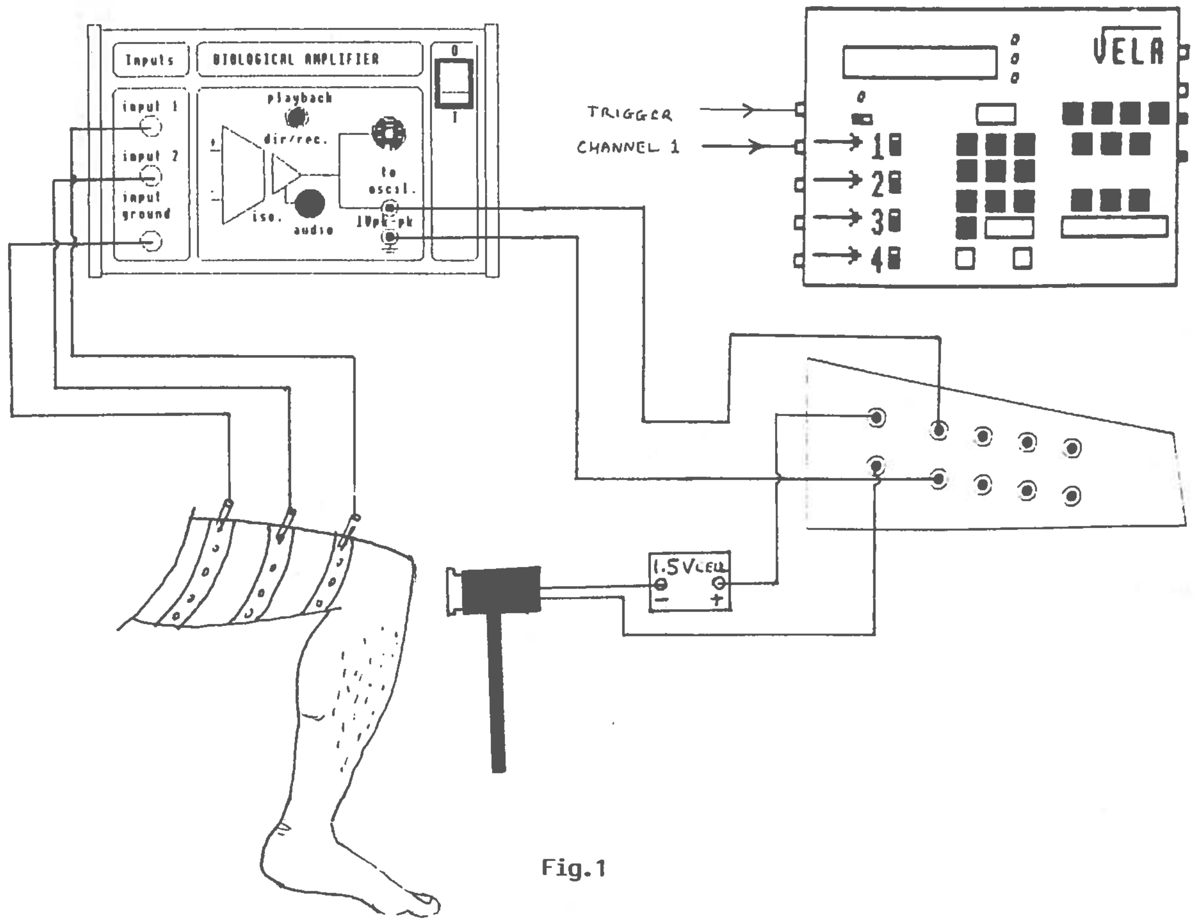


Fig.1

The 1V peak to peak output from the Unilab Biological Amplifier is not directly compatible with the 0-1 V input of EMU. There are possible ways around this snag and we would extend our offer of technical help to cover this device also.

Procedures

The equipment should be set up as in Fig.1.

In order that the datalogger starts logging from the time the tendon is stimulated, a triggering mechanism must be used. There are several possibilities with the use of:

- metal foil over the tendon and hammer in a circuit with a 1.5 V cell. When stimulation takes place, an electrical contact is made and the datalogger will start to log the voltage data (refer to the manufacturer's instructions for the Unilab Biological Amplifier for further detail);

- a light gate over the tendon; when the hammer passes through the light beam it triggers the datalogger;

- a hammer with a microswitch built into the head.

We have recently trialled both the second and third methods. The light gate method, whilst producing good results, has the problem that if the subject moves their leg this usually results in the datalogger triggering before the experiment has actually begun. The positioning of the light gate over the tendon is critical - it must be as close as possible to the tendon itself without the tendon breaking the beam. Of the two methods we tried, we thus found the hammer/microswitch method to be the better.

Construction of a tendon hammer (DIY)

35mm film tub
microswitch (push to make). Available from SSERC - Item no. 631a 25 p. (or RS equivalent)
spring
plastic water pipe (ca.30 mm i.d.)
handle (made from a rod of any suitable material)
1.5 V cell

Many of the design features and dimensions of this hammer (Fig. 2) are not critical. The design may be adapted to use other materials more readily to hand. The features which do matter are:

-a hammer head sufficiently light and broad (ca. 40 mm o.d.) as to avoid injury;

-switching of the microswitch by the smallest possible travel of the spring loaded head.

We found that it was necessary to bend slightly the arm of the microswitch to 'tune' the mechanism to meet that second requirement.

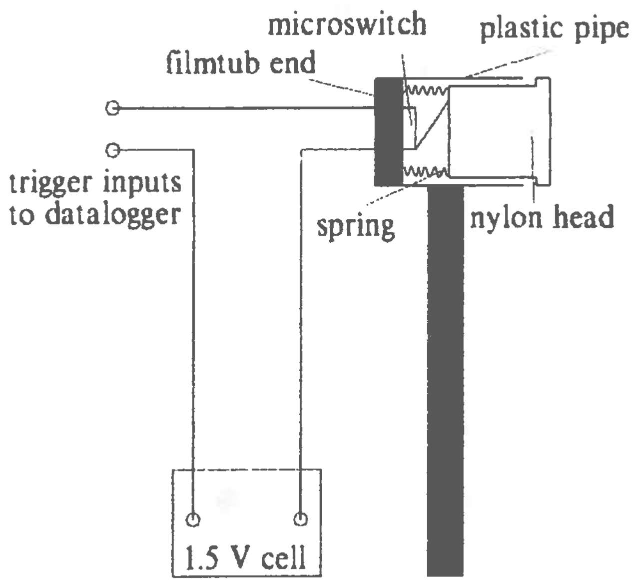


Fig.2

Whatever the chosen method of triggering, the mechanism is connected to the "Pulse Input" sockets located on the lefthand side of VELA. The small switch at the top lefthand side of the VELA keyboard should be moved over to the left ("Pulse") position.

Qualitative exercise

Connect the amplifier to VELA as shown in Fig.1, ensuring that the voltage range switch on Channel 1 is set to +/- 2.5 V. Connect an oscilloscope to the relevant VELA outputs.

On the VELA keyboard press **<RESET>, <01>, <2>, <ENTER>.** The datalogger is now ready to capture data when the triggering mechanism is activated. Ensuring the amplifier is switched on, and the subject has relaxed their leg muscles, tap the tendon with the hammer. The datalogger should trigger and start logging the incoming voltage data. When logging has stopped the VELA display will flash "O-P".

This data can be displayed directly on the oscilloscope and the pattern of the nerve/muscle impulses clearly seen.

Measuring the latency

With VELA connected to a BBC Computer the data can be better examined by downloading it into software such as Philip Harris 'Datadisc' or 'Datadisc +'*. The latency period can be estimated from the screen display or determined more accurately from the individual data values. If required a printout of the graph or a table of results may be obtained.

(*Note that the current Archimedes version of 'Datadisc +' does not support this facility).

Results

Shown are results from stimulation of the patella tendon on subject A (Fig.3), subject B (Fig.4) and the Achilles tendon (Fig.5). Measurement of latency is possible by measuring how far along the x-axis the large voltage change occurred. (Remember that time on the x-axis is in fact the time from stimulation). In our results for adults this was approximately 40 ms. It would then be possible to estimate the speed at which the nerve impulse travelled along the reflex arc and compare this against published values. If the impulse was purely electrical, at what speed should it travel?

The plots produced appear to suggest that both persons had their own distinct contraction pattern. Our results have shown that each subject reproduced the same wave pattern each time.

When VELA is set up on program <01>, the complete data is logged over 560 ms on Channels 1 - 4.

VELA stores the first section (0-140 ms) of data from the biological amplifier on Channel 1, the second (141-280 ms) on Channel 2 and so on. Figures 3 and 4 were obtained by printing out a graph of the data held in each channel. The four graphs were then pasted together thus providing a graph of the complete data. These graphs demonstrate that after stimulation it takes some time for the muscle to return to the resting voltage (over 400 ms in the case of the knee-jerk reflex). This "after-discharge" can often persist at full intensity for many seconds after the stimulus ends and then relaxes gradually [2].

Summary

As well as allowing a qualitative demonstration for Standard Grade and a quantitative one at Higher this procedure should open some doors to imaginative project work (particulary for CSYS). Possible studies include looking at the effects of fatigue, continual stimulation of the muscle on the length of latency and the effect of subject height on latency.

References

1. Green, J.H., 1972, "An Introduction to Human Physiology", 3rd edition, ISBN 0 19 263318 X, Oxford University Press.

2. Manning, A., 1972, "An Introduction to Animal Behaviour", 2nd edition, ISBN 0 7131 2361 3, Edward Arnold.

* *

Figs.3,4 & 5 overleaf

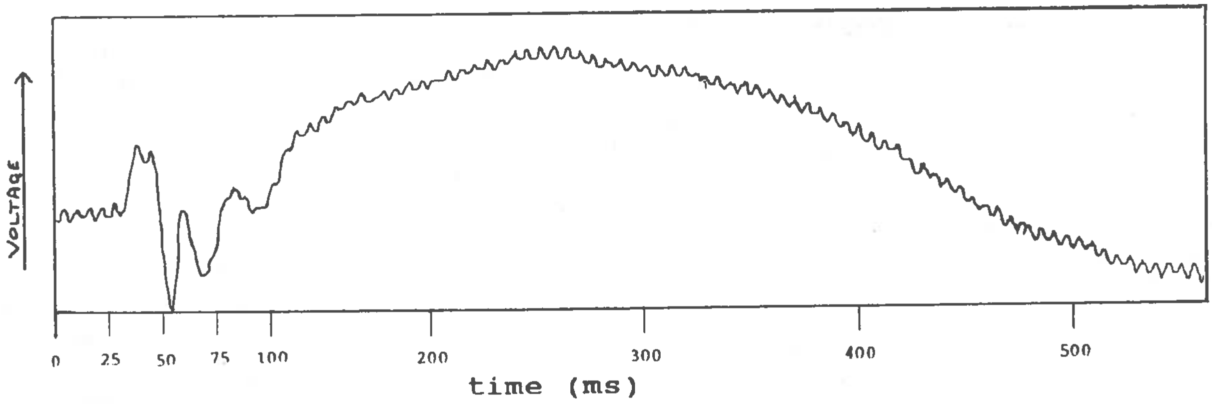


Fig.3 - Knee-jerk reflex (Subject A)

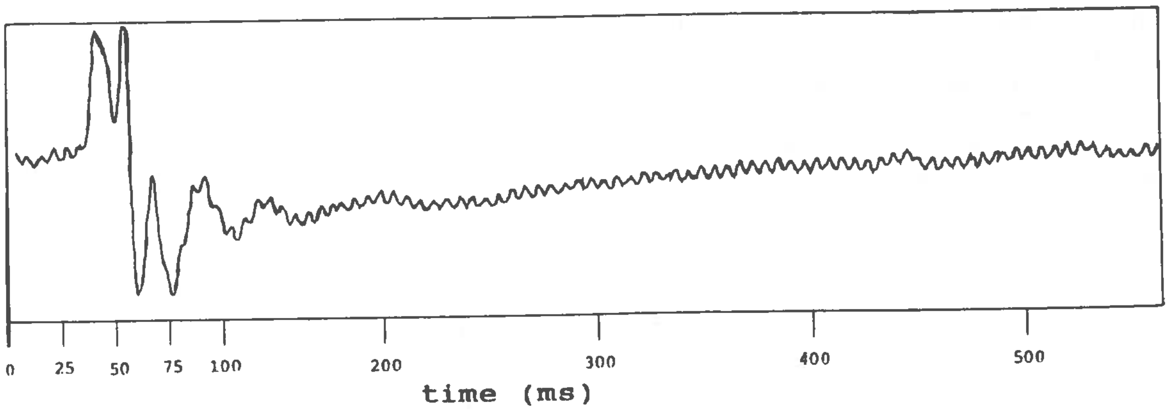


Fig.4 - Knee-jerk reflex (Subject B)

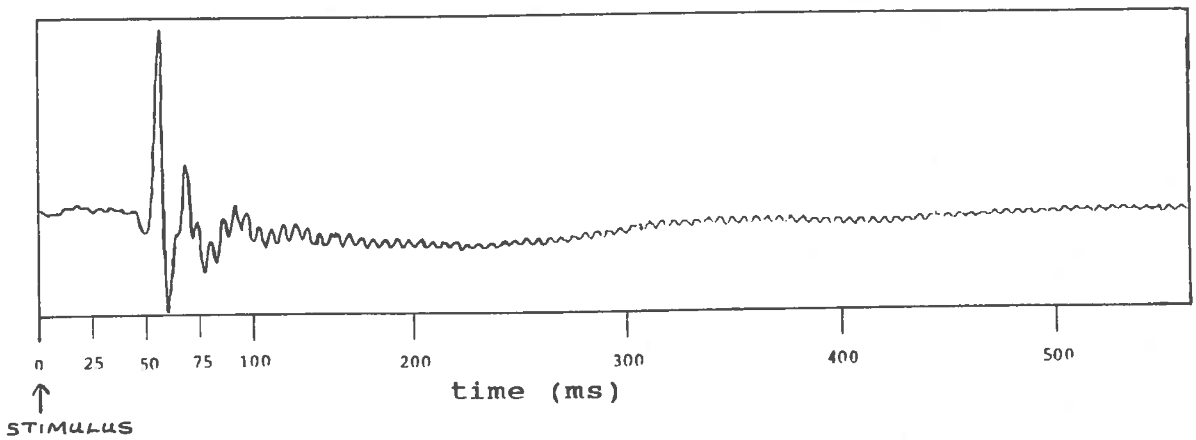


Fig.5 - Ankle-jerk reflex

Gas Volume Determination - another method

A recent well documented method for measurement of gas volume is the coupling of a syringe to a position transducer. The one snag with this system is that it relies on the use of a precision glass syringe. These can be purchased from Weber Scientific (circa £2.08 for 20 cm3, £5.18 for 50 cm3) and other suppliers.

When using a precision glass syringe the ground glass surfaces must be kept completely dry and free from grease of any kind, otherwise they have a tendency to stick.

Another method for gas volume determination has been suggested by Sid Gallagher of Campbeltown Grammar. This method (Fig.1) still allows access to interfacing packages but without the requirement for a precision glass syringe.

Gas evolved from the culture or reaction mixture passes along the delivery tube into the measuring cylinder displacing the liquid. As the liquid level falls the small float moves down and the position transducer takes up the slack in the thread. The tube from the reaction vessel as well as acting as a delivery tube also provides a turning point for the thread.

Equipment Required

The following items should be used for volumes up to approx 50 cm3 :-

100 cm3 measuring cylinder
1 l beaker
18 mm diameter polystyrene ball

The polystyrene ball may on occasion stick to the inside wall of the measuring cylinder. One way around this is to place four x 10 mm lengths of steel wire (from paper clips) through the ball at right angles to one another (Fig.2). It is also helpful to smear the outside of the ball with water repellent grease i.e. silicone. The ball can be attached to the thread by means of a small self tapping screw such as a No.6.

Were this a fermentation experiment it may be desirable to leave the experiment running for a few days. In this case the volume of evolved gas may be too much for the 100 cm3 measuring cylinder to cope with.

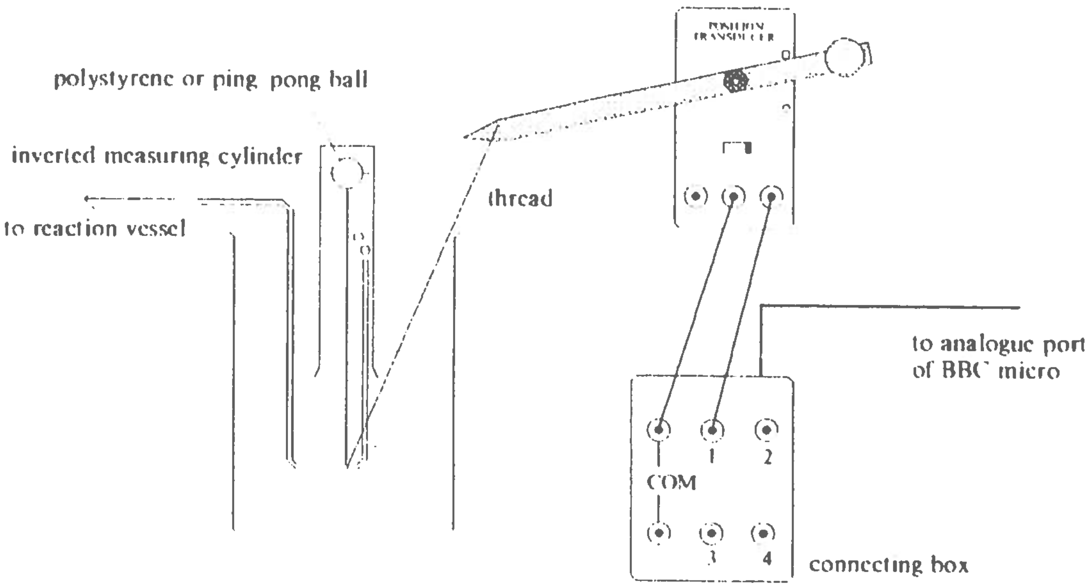


Fig.1 Gas volume determination

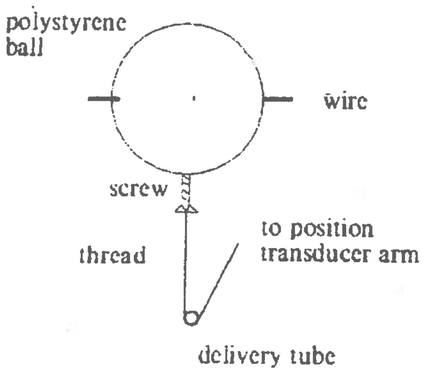


Fig.2 Float attached to position transducer

To collect volumes of around 150 cm3 the following equipment should be used:-

500 cm3 measuring cylinder
basin
ping-pong ball

In either case the following points should be noted:

1. Keep the position transducer as close as possible to the measuring cylinder in order that the relationship between the gas volume and position transducer arm is as linear as possible.

2. Four wire arms and silicone grease around the ball help reduce water tension between the cylinder walls and the ball. The movement of the float will become more steady and the trace produced by the position tranducer should thereby be reasonably smooth.

3. The point on the glass delivery tube which the thread makes contact with should be well below the measuring cylinder to ensure the thread is not restricted by the beaker lip.

4. The position transducer can be calibrated using a syringe to displace some of the water in the measuring cylinder.

5. Two small pieces of insulating tape should be placed around the delivery tube on both sides of where the thread bears. These act as guides helping to prevent the thread moving too far along the tube thus maintaining a nearly linear relationship between the arm movement and gas volume.

6. If the experiment is required to run over a long period of time the gas evolved should be collected over brine. The amount of carbon dioxide dissolving in the solution will thereby be reduced.

* * * * * * * * *

Buffers - a market survey
- DIY preparations

Abstract

This article is split into two parts:

Market survey - The costs of chemicals used in DIY preparations of buffers are compared with those of commercially available buffer solutions, sachets and tablets.

DIY preparations - The details for a number of buffer solutions are described.

Introduction

Someone in SSERC recently asked "Just how much does it cost for one of these wee sachets each time I make up a buffer solution?" The answer of 50p, looking at current prices, came as quite a shock. This stirred us into investigating the chemicals used in buffer solutions and whether there were any cheap and easily prepared substitutes.

Market survey (Table 1)

All chemical costs quoted refer to 'AnalaR' grade and were taken from the BDH catalogue. Costs of ready-made packs came from the same catalogue or that of Russell pH.

The column entries in Table 1 require some explanation:

columns 1-5 refer to the chemical(s) used to make a DIY buffer

6-8 describe the nearest commercial equivalent package

column 5 shows (a) the unit cost (in brackets) of the mass of chemical entered in column 4 and (b) the cost (not in brackets and immediately below) of making 100 cm3 of solution of molarity shown in column 3.

column 8 gives information about the commercial equivalent and corresponds to column 5. The first figure is the cost of the pack size () and the second the cost/100 cm3 of buffer solution.

To get an impression of the difference in costs between DIY and commercial buffers simply compare the non-bracketed figures in columns 5 and 8. It is obvious that the latter are generally over 10 times more expensive. In the next section we summarise what is involved in preparing your own buffers.

DIY preparations (Table 2)

Buffers by definition are solutions which have the ability to counteract a change in pH due to dilution, temperature change or contamination. Hence they are used as standards to carry out two-point calibrations on pH meters and their probes.

How tolerant then, are buffer solutions to inaccuracy of preparation? Could a rough-and-ready approach be employed. Could a quick method be used in the field by the biologist to set up a pH meter?

The results of our benchwork are shown in Table 2 where we compare the pH of an accurately prepared buffer solution with that obtained by a 'spatulaful(s) in a 100 cm3 beaker' method. Note that the spatula used was of the Nuffield stainless steel type as quoted in the SSERC Standard Grade Chemistry Equipment List. It is 140 mm long and the scooped end was used.

Compare the pH readings in columns 5 and 7 and you will see that they are identical. Beware however of using the potassium trihydrogen dioxalate and calcium hydroxide in the calibration of meters as their pH values can drift.

There is a body of theory which allows application of temperature compensation co-efficients to different buffer systems. Similarly it is possible to predict the effects of dilution. Our benchwork has shown us however that in practice, for other than critical applications or absolute measurements, the effects of variation in temperature even of as much as 20°C or dilution by a factor of 2:1 can be ignored when using a school pH meter of typical accuracy and readability.

pH at 25°C	DIY chemicals required formula, Molecular Wt. & Cat. No.	molarity (M)	quant. (g)	cost(£) (/unit) /100cm3	Supplier – commercial equivalent	Cat. No.	cost(£) (/unit) /100cm3
1.48	**potassium trihydrogen dioxalate** $KH_3(C_2O_4)_2.H_2O$, 254.19, 10221 3C (potassium tetraoxalate)	0.05	250	(10.30) 0.05	–	–	–
4.005	**potassium hydrogen phthalate** $KHC_8H_4O_4$, 204.22, 102074J	0.05	250	(7.60) 0.03	BDH – 50 sachet box	33189 2M	(23.50) 0.47
					BDH – 50 tablet box	33154 2Q	(8.50) 0.17
					BDH – conc. solution 6 ampoules/carton	18048 1G	(18.80) 0.63
					BDH – Sorensen's, Clark & Lub solutions (1 l)	19034 4D	(6.80) 0.68
					Russell – 50 capsule box		(25.00) 0.50
					BDH – Colourkey buffer solution, 250cm3 (RED)	19239 3U	(3.40) 1.36
5.8–8.0	**potassium dihydrogen orthophosphate** KH_2PO_4, 136.09, 10203 3A	0.025	250	(4.60) 0.01	BDH – 50 tablet box	33155 2S	(8.00) 0.16
	+				BDH – 25 sachet box	33190 2U	(21.90) 0.44
	di-sodium hydrogen orthophosphate $Na_2HPO_4.12H_2O$, 358.14, 10203 3A	0.025	500	(5.30) 0.01	BDH – conc. solution 6 ampoules/carton	18051 1S	(18.80) 0.63
					BDH – Sorensen's, Clark & Lub solutions (1 l)	19034 4D	(6.80) 0.68
5.8–8.0	**di-sodium hydrogen orthophosphate** $Na_2HPO_4.12H_2O$, 358.14, 10203 3A	0.2	500	(5.30) 0.08	Russell – 50 capsule box		(25.00) 0.50
	+				BDH – Colourkey buffer 250cm3, (YELLOW)	19240 3F	(3.40) 1.36
	sodium dihydrogen orthophosphate $NaH_2PO_4.2H_2O$, 156.01, 10245 4R	0.2	500	(6.60) 0.16	BDH – Universal buffer pH2.7–11.4	33022 2W	(4.10) 0.41
9.18	**di-sodium tetraborate** $Na_2B_4O_7.10H_2O$, 381.36, 10267 3D	0.01	250	(3.50) 0.03	BDH – 50 sachet box	33191 2W	(24.50) 0.49
					BDH – 50 tablet box	33156 2U	(6.50) 0.17
					BDH – conc. solution 6 ampoules/carton	18053 1W	(18.80) 0.63
					BDH – Sorensen's, Clark & Lub solutions (1 l)	19041 4A	(9.40) 0.94
					Russell – 50 capsule box		(25.00) 0.50
					BDH – Colourkey buffer 250cm3, **pH10**, (BLUE)	19241 3H	(3.40) 1.36
12.45	**calcium hydroxide** $Ca(OH)_2$, 74.1, 10304 3G	satd.	250	(35.10) 0.05			

Table 1 – Comparing DIY buffer preparations with commercial packs

Hazards

Most of the DIY buffers listed in Table 2 do not require special precautions as they are of low toxicity. The following exceptions should be noted:

potassium trihydrogen dioxalate (potassium tetra-oxalate) is harmful and toxic by ingestion, inhalation or skin contact; avoid raising dust and wear gloves and eye protection.

calcium hydroxide is corrosive; avoid contact with the skin; wear gloves and eye protection.

Shelf life

If prepared with water free of carbon dioxide and kept in a closed polythene or glass bottle the pH value of a buffer solution stays the same for several months. Many buffers will eventually grow mould or gradually absorb carbon dioxide. Others, like borax, will undergo partial polymerisation. Several commercially prepared buffers contain fungicides. If there is doubt about the accuracy of a buffer solution, it is simplest to replace it by a freshly prepared solution. As you can see the cost to the DIY chemist is negligible.

Chemical(s)	Mol. Wt.	molarity (M)	g/100 cm3	pH	spats./100 cm3	pH
potassium trihydrogen dioxalate	254.19	0.05	1.27	1.92	2	1.92
potassium hydrogen phthalate	204.22	0.05	1.02	4.01	3	4.01
potassium dihydrogen orthophosphate	136.09	0.025	0.34		1 in 300 cm3	
+						
di-sodium hydrogen orthophosphate	358.14	0.025	0.895		3 in 100 cm3	
1:1 mix of two solutions above				6.86		6.86
di-sodium tetraborate	381.36	0.01	0.38	9.03	5	9.03
calcium hydroxide	74.1	saturated	0.37	11.45	1	11.45

Table 2 - DIY buffer preparations (accurate and rough methods)

* * * * * * * * *

DIY transducers for distance & velocity v. time

Abstract

Designs are outlined for two novel, cheap and easily constructed transducers with voltage outputs directly proportional to (1) distance and (2) velocity. Several applications are described.

Distance measurement

The method consists of attaching a thread between the body whose movement is to be observed and a pulley wheel mounted on the spindle of a low-friction, multi-turn potentiometer (pot). Initially the thread should be fully wound round the wheel. When the body moves away from the wheel the turning causes the potential on the wiper terminal of the pot (Fig.1) to vary linearly with the range of the moving body. Changes in this potential are recorded on some form of datalogger to give a continuous display of distance versus time. A further dropping resistor in series with the pot may be required to get the best match between the power supply voltage and data logger input range, in our example 1.5 V and 1.0 V respectively.

Figure 1 shows an arrangement to obtain a continuous plot of distance versus time. In this example the datalogger is a BBC Computer with Unilab Interface.

The pot resistance should lie somewhere between 1 kΩ and 100 kΩ. The wiper arm must have low dynamic friction and have at least ten turns. There are suitable pots in our surplus stock, e.g. item BP2017 @ 50p, a 10 kΩ, 10 turn Beckman pot with 6 mm diameter spindle.

Both diameter of pulley wheel and number of pot turns affect the useful range of the device. A wheel we found suitable was stripped off an electric fan (SSERC item 344 @ £4.50). This wheel conveniently fits on a 6 mm dia. shaft, similar to that of the pot. With a rim diameter of 0.16 m the

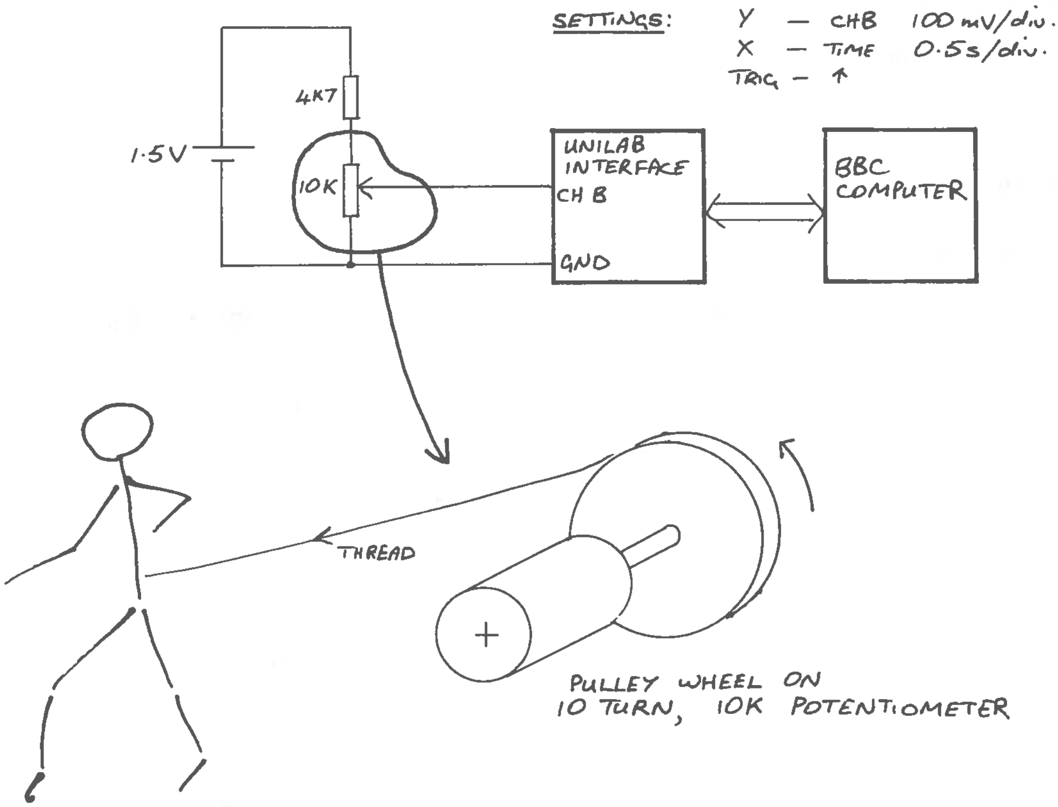


Fig.1 - Apparatus to obtain distance versus time

range obtainable with a 10-turn pot is 10 x 3.14 x 0.16, or 5 metres - suitable for monitoring the movement of a person.

If smaller scale experiments were being undertaken such as following the movement of a linear air track vehicle or dynamics trolley a smaller pulley wheel taken from a laboratory block and tackle kit would suffice.

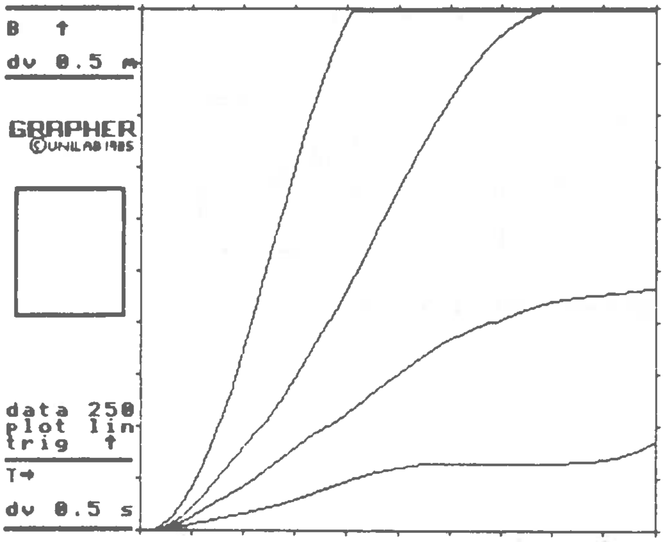


Fig.2 - Superposed graphs of distance v. time

An example (Fig.2) of a number of superposed recordings of the movements of persons starting from rest shows what can be expected from this method. In this instance the y-axis had been calibrated in 0.5 m/div. Note that if only qualitative relationships are wanted, such as is often the way, calibration like this would be unnecessary.

Velocity measurement

A version of this method, of which the basic idea was originally described in Bulletin 160, consists of attaching a thread to the body whose movement is to be observed and turning the thread quarter round a pulley wheel mounted on a precision motor. The motor is used as a generator, the voltage generated corresponding linearly with the velocity of the moving body. If a datalogger monitors this voltage then records of velocity versus time can be obtained.

In the applications described below the pulley wheel is an aluminium one removed from a laboratory block and tackle kit. It has a diameter of 50 mm.

Why repeat an idea we have just published? We have very recently applied the technique to several standard mechanics experiments and found it works splendidly. To these we want to draw your attention.

APPLICATION 1 - Newton's 2nd Law - a versus F in under 5 minutes!

A vehicle is accelerated along a linear air track by a slotted mass suspended by thread over the end of that track (Fig.3). This thread bears on a pulley wheel mounted on the shaft of a precision motor. If the linear air track does not have a mount for such a pulley wheel then the motor and wheel can be held in position by a clamp stand. Any obstruction that ensues from this support does not affect the experiment since motion along only a small length of track needs to be observed.

The total accelerating mass (m + M) must be kept constant. If a total of four slotted masses are used to vary the accelerating force by four stepped units then masses not placed on the weight carrier to exert the accelerating force must be stored on the linear air track vehicle, not on the bench or floor.

Use either 5 g or 10 g slotted masses to suit your linear air track kit. The optimum value depends on the type of kit. Whatever the basic unit of slotted mass it is desirable that the weight carrier either equals this or has a negligible mass. For instance if you find that the optimum accelerating mass unit is 5 g but you do not have a 5 g weight carrier then you could improvise a lightweight carrier out of a short length of copper wire having a mass much less than 1 g. If necessary friction compensate the track to annul any accelerating effect of the weight carrier.

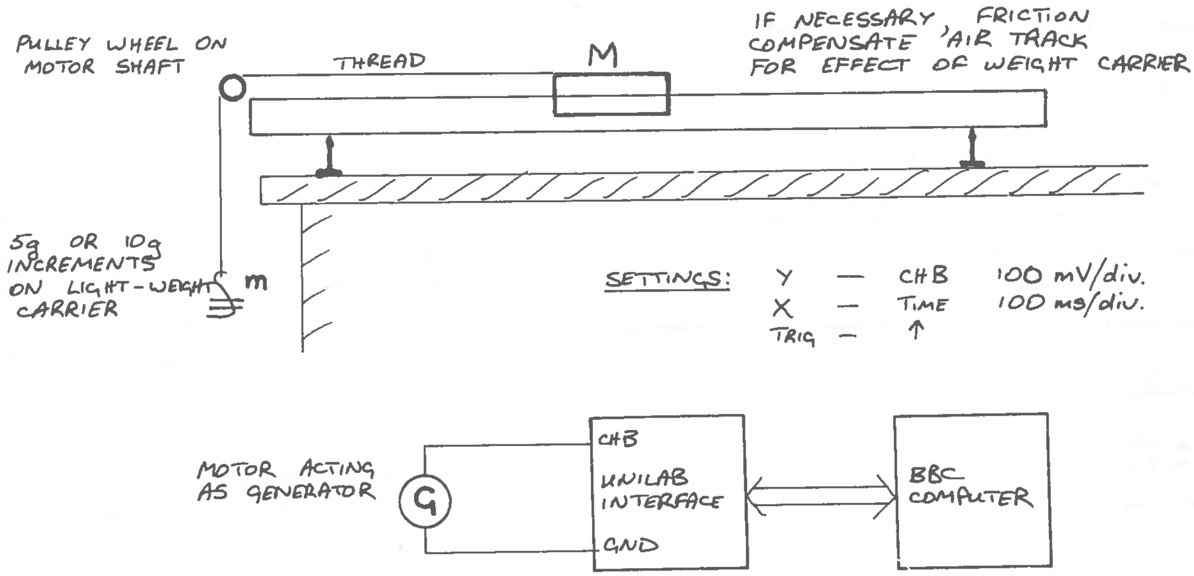


Fig.3 - Velocity measurement of linear air track vehicle

In this application the software used must have a facility allowing measurement of the gradients of the graphs obtained. It is important that this can be done slickly so that unskilled users can readily obtain readings. Suitable software in this respect is Grapher by Unilab (532.052), which should be used with the Unilab Interface (532.001).

Results

Figure 4 shows an example of four superposed graphs of velocity versus time. The y- and x-axes scales are 100 mV/div. and 100 ms/div. respectively. No attempt has been made to calibrate the y-axis in units of velocity as, for the purpose of this experiment, it is unnecessary.

The intercept on the y-axis is the value of the trigger voltage, about 40 mV. This could have been reduced further to a negligible value by turning down the Trigger Sensitivity control on the Interface.

Gradients (Table 1) of these four lines were obtained by a special facility in Grapher software. They bear a linear relationship to the accelerating force (Fig.5).

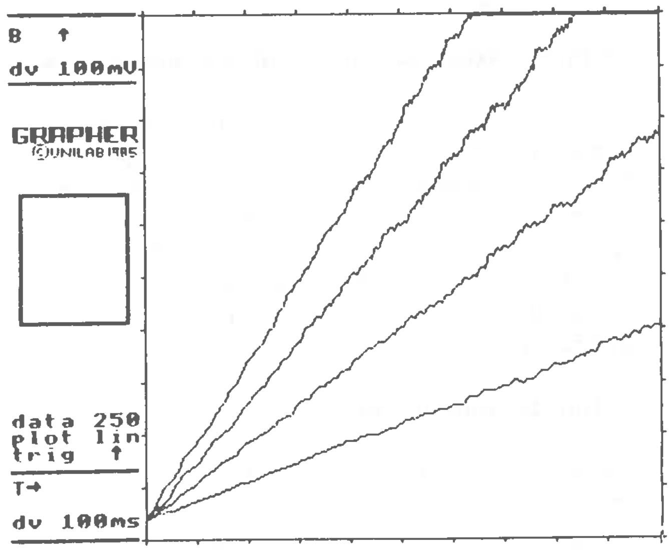


Fig.4 - Four superposed graphs of velocity v. time

Force	Gradient
1	0.38
2	0.73
3	1.15
4	1.49

Table 1 - a versus F experiment - arbitrary units

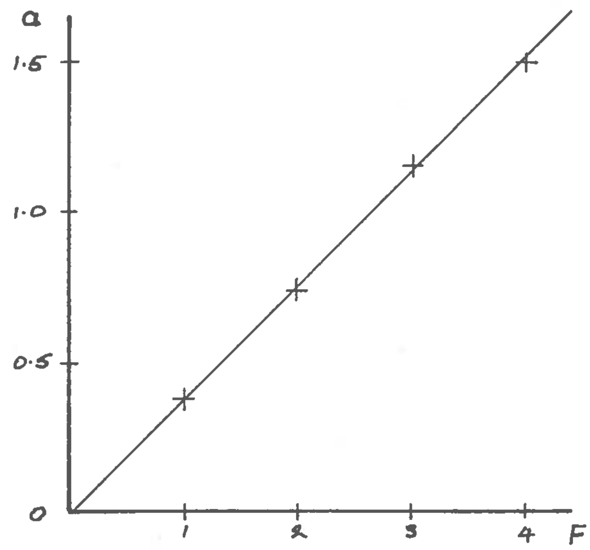


Fig.5 - Dependence of acceleration on force

It should be noted that obtaining these four gradients from first switching on the linear air track took less than four minutes.

APPLICATON 2 - Free-fall acceleration

The independence of acceleration on mass can be shown by suspending masses, one by one, from the pulley wheel and letting them free fall about half a metre. If the graphs of velocity versus time are superposed they should all coincide.

APPLICATION 3 - Compound effect of two forces

In this experiment a precision motor is mounted on a dynamics trolley or home-made buggy such that the shaft of the motor is coupled to one of the vehicle's wheels. A lightweight flying lead conveys the signal generated to a datalogger. It is essential that this has a bipolar input so as to be able to record negative as well as positive voltage signals. Two dataloggers which suffice in this respect are (1) the Unilab Interface with Grapher software, and (2) VELA.

If, as described in Bulletin 160, the vehicle is placed at the foot of a sloping trolley board and shoved uphill then gravity and friction are additive in opposing the uphill part of the motion but subtractive in accelerating the vehicle downhill (Fig.6).

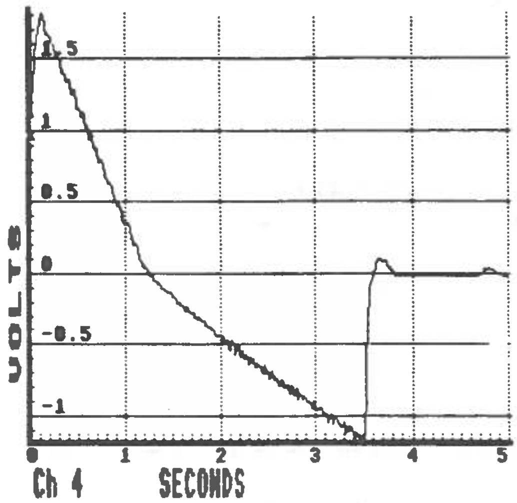


Fig.6 - Velocity v. time for up and down hill

Figure 6 was recorded on VELA, the data being transferred to a BBC Computer using Datadisc (Harris, A29017/8, etc.) to make the screen dump to a printer.

Facilities in the software required for this application should include the ability to (1) measure gradients, and (2) perform integration. Both Datadisc Plus (latest version of Datadisc, A29025/7) and Grapher have these facilities. The former is considered to be the more powerful, but can be slower to operate and needs to be used with VELA when working with a bipolar signal. The latter gets results faster.

Technical notes on precision motors/over

Technical notes on precision motors

Several features are required in choosing a motor to work as a tachogenerator in the applications just described:

- a linear transfer function (or in other words an output voltage which is directly proportional to velocity);

- very low frictional torque; and

- a commutator having a large number of segments (or windings).

We presently stock four Portescap precision motors (Table 2) meeting these criteria.

Surplus item no.	Description	No. of segments	Typical ripple pk-pk
594	motor	9	5%
626	motor	9	4%
627	motor/tacho	9/5	2-3%/7%
628	motor	9	2-4%

Table 2 - Surplus stock of precision motors

The magnitude of ripple relative to d.c. level (Fig.7) depends on the number of segments in the commutator. With this quality of motor the effect of ripple is negligible - even at slow speeds (Fig.4) (using no. 594).

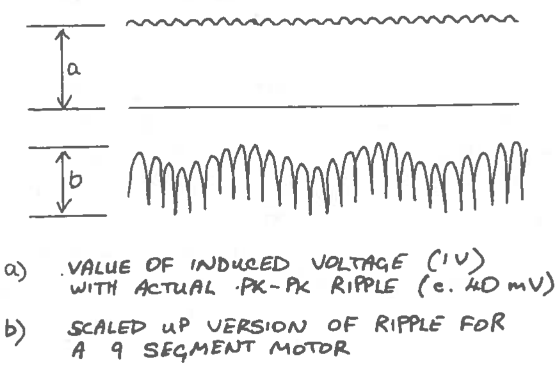


Fig.7 - Typical generator output signal

Calibration

The velocity sensor can be calibrated, the means depending on the application.

However some teachers may feel that working in arbitrary units of velocity is usually adequate for the purpose and preferable to using SI units because of the time and effort which would have to be taken in carrying out a calibration.

Practical snags

The following points cover both the distance and velocity transducers:

1. Overrunning at the termination of motion - this results in a distortion at the end of the graph: it can often be avoided by a judicious change of the time scale and repeating the event.

2. Thread jitter - vibrations in the thread can cause a cyclic variation in the graph which is usually minor (Fig.4).

3. Generator ripple - very small (Fig.4).

4. Non-linearity at very low speeds - in the examples shown (Fig.4) this effect is not apparent. However a stepped, non-linear response from the generator is occasionally seen at voltages up to 300 mV.

Advantages of methods

1. They provide good quality, continuous records of movement and would be particularly suitable for Higher Grade Physics usage.

2. Obtaining results (in uncalibrated mode) can be quick and slick.

3. Their means of operation depend on elementary principles already taught in school. Therefore pupils should be able to understand how they work and this should help underpin existing concepts.

* * * * *

An op-amp tachometer

Abstract

The back e.m.f. of a motor is directly proportional to its angular speed. In this method the back e.m.f. is derived algebraically by subtracting the voltage dropped across a series resistor from the voltage developed across the motor. The output signal is thereby a function of speed.

Description

This circuit deserves attention because it (1) is an example of an algebraic manipulation of signals by op-amps, and (2) demonstrates some important properties of electric motors.

A resistor Rm should be connected in series with a motor such that the resistance of Rm equals the the resistance of the motor windings. The resistor and motor are connected between the positive power rail Vs and the 0 V rail, Rm being next to 0 V (Fig.1).

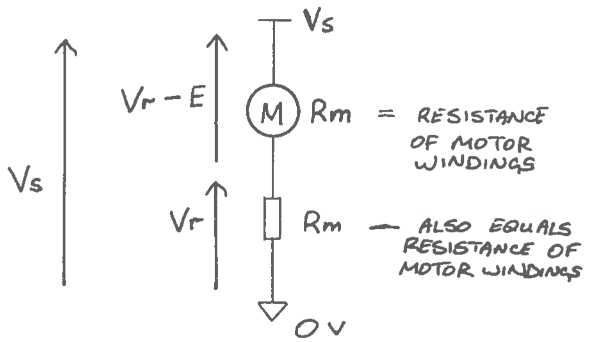


Fig.1 - Motor and series resistor Rm

We can derive the expression (1) for E, the back e.m.f., by subtracting the potential differences developed across the two components.

$$Vs = (Vr - E) + Vr$$

$$\Rightarrow Vs = 2Vr - E$$

$$\Rightarrow E = 2Vr - Vs \qquad (1)$$

But E is linearly dependent on ω, the angular speed. Therefore the angular speed is a linear function of (2Vr - Vs) (2).

$$\Rightarrow \omega = k(2Vr - Vs) \qquad (2)$$

This function is obtained electrically by a circuit comprising two op-amps (Fig.2). Op-amp 1 is wired as an inverting amplifier with a gain of 2. The signal on its output is -2Vr. Op-amp 2 is wired as a summing amplifier with unity weighting and gain. It adds -2Vr to Vs and inverts the sum the produce the desired function (2).

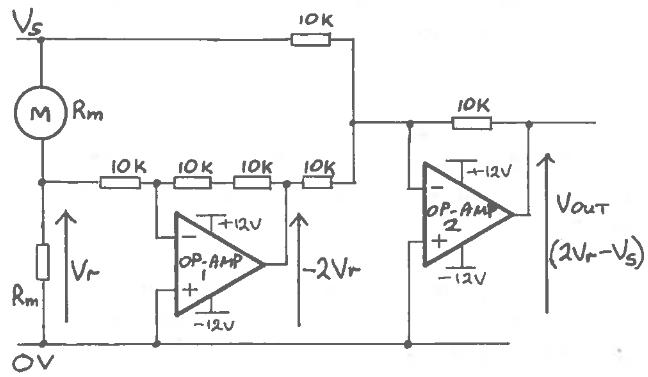


Fig.2 - Op-amp tachometer circuit

Any cheap bipolar (e.g. 741) or BIFET (e.g. TL071CP, TL081CP) op-amp can be used. A dual op-amp such as TL082CP (RS 304-217) would be very suitable.

A point to note is that two distinct power supplies are required: (1) a supply Vs for the motor, which might be a battery of 1.5 V cells, and (2) a dual rail supply for the op-amps whose voltage must exceed Vs. For instance a suitable choice would be using a battery of four 1.5 V cells for Vs and a +/-12 V dual rail supply for the op-amps. With such a choice Vs can be stepped up to 6 V in four stages to test the operation of the system at different speeds.

The two power supplies need a common 0 V rail.

Deliberately, all resistor values, apart from Rm, are the same. This assists the matching necessary for good performance. The cheap way to do this is by selecting ordinary 5% tolerance values from the one packet - they often are very close.

The motor shaft should be clamped whilst measuring the resistance of the windings. A nine segment motor has nine separate windings, each of which has the same resistance.

Any SSERC precision motor would suit this application because of their high number of segments and consequent low ripple. Item 627 is especially suitable. It has a motor coil and tacho coil mounted on a single shaft. Its tacho output can then be used to check the performance of the op-amp tacho system.

Motor speeds can also be directly obtained using one of the optical encoders we stock (items 378 and 642) and a slotted opto-switch and frequency meter.

Figure 3 shows the performance. The system output (y-axis) is plotted against the signal derived from the attached tachogenerator (x-axis).

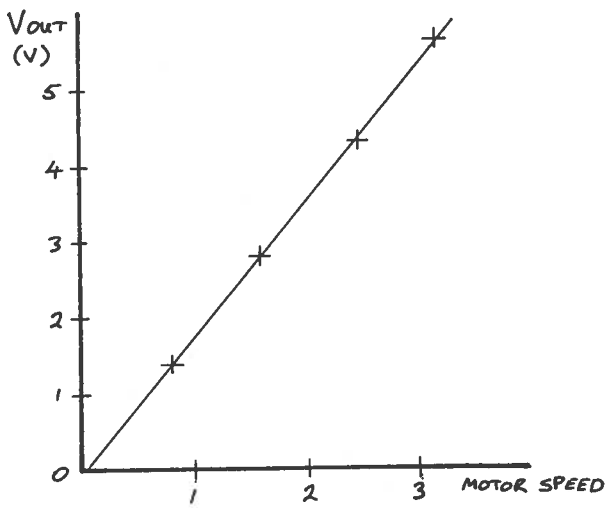


Fig.3 - Performance: Vout versus ang.speed

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Evaluation Report - The Motion Sensor

Description

The Motion Sensor is an ultrasonic rangefinder linked to a BBC Computer through the computer's User Port. In usage the Sensor is clamped in a stationary position and sends out and receives back ultrasound to and from a moving target. The computer processes the signals to produce real-time graphs of distance, velocity and acceleration versus time. Targets can be the traditionally studied moving bodies such as trolleys, linear air track vehicles, objects in free-fall, or pendulum bobs. Targets can also be moving bodies whose motion is seldom quantitatively, though sometimes despairingly, studied in school laboratories - pupils!

The power of the instrument lies in its abiltity to provide instantaneous graphs, and to observe the movement of persons. Educational benefits should come from this. For instance children can experience for themselves what it is like to move at a constant speed of 1 ms^{-1}, or accelerate at 1 ms^{-2}. With direct graphical feedback they can observe, modify and retry until they achieve what they are looking for. They therefore have a chance of picking up a tacit understanding of concepts that, by traditional means, are often dealt with more abstractly.

The Motion Sensor and software are supplied as one purchase unit (order code 9200) by Educational Electronics, price £60. They have been developed by the Leicester University School of Education as part of the "Tools for Scientific Thinking" (TST) project funded by the Microelectronics Education Support Unit (MESU). Further software, teaching notes and pupil material are to become available in January 1990. We understand these have been written to suit a wide age group from late primary through secondary.

How it works

The Motion Sensor contains a Polaroid electrostatic transducer which both transmits and receives ultrasound. This is operated by a specialized i.c. made by Texas Instruments, the SN28827 Sonar Ranging Module.

According to the technical specification we have the transducer sends a train of sixteen pulses at a frequency of 49.4 kHz. Simultaneously with the onset of these pulses an internal blanking signal (Fig.1) inhibits the receiver part of the system for a period of 2.38 ms. This prevents transducer ringing being detected as a return signal. Echoes can be received from targets after this blanking signal ends. The sample rate is 20 Hz.

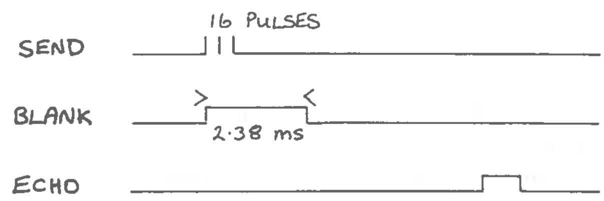

Fig.1 - Control signals

Range is computed from the period taken to wait for an echo. There is, because of the blanking signal, a minimum separation between the transducer and target for which a range can be determined. This is about 30 to 40 cm. The maximum operational range is 11 m, but this is limited by software to 6 m.

The minimum size of target depends on the wavelength, which is 6.8 mm. We found that targets of 10 mm and above can be detected. The target need not be flat; curved surfaces such as 10 mm diameter rod make suitable targets if used under favourable conditions. However for consistently good results, especially at a distance of a few metres, the target had to be flat and smooth.

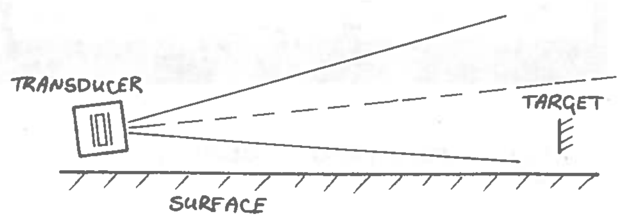

Fig.2 - For targets near to surfaces

Radiation from the transducer is extremely directional, falling to -30 dB at 15° from the normal to the face of the transducer. Targets positioned near a large surface can be reliably detected only by pointing the sensor away from the surface (Fig.2) at an angle of about 5° to 8°, thus reducing the chance of the surface itself giving off a false signal.

How it performs

The hardware and an early version of the software were evaluated by the Centre in June 1988.

Setting up the instrument and operating the software were found to be straightforward and not difficult. Measurements were reasonably accurate. Errors in distance never exceeded 5 mm within a range of one metre.

A printout (Fig.3) of a screen display shows the sort of graphical information which the system can give. The display includes superposed plots of distance and velocity versus time. The axes are scaled in SI units. The ordinate transecting the display can be shifted left or right by software. The actual values of coordinates cut by this line are displayed at the top of the screen, but do not appear on the printout.

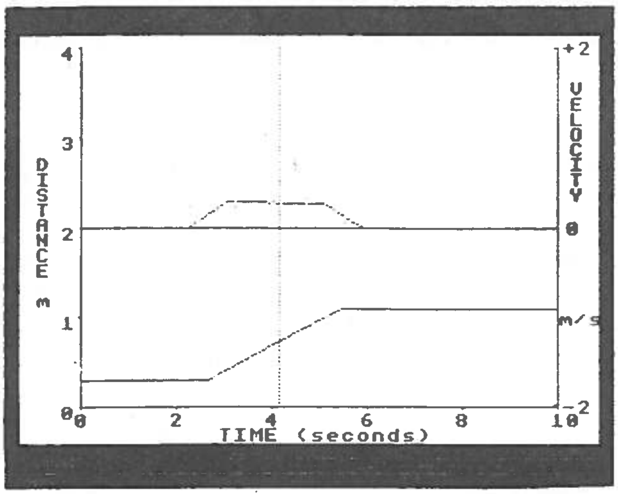

Fig.3 - Moving with constant velocity

Figure 3 was obtained by monitoring the motion of a trolley along a friction compensated slope such that the trolley apparently moved at constant velocity. Any irregularities in the actual acceleration and deceleration at the beginning and end of the motion do not show up in the graphs. These are of a simplicity which matches those to be found in elementary textbooks.

The second printout (Fig.4) shows an example of one of the distance versus time plots which pupils are asked to emulate. The ragged plot superposed is our attempt at matching. This calls for care in scrutinizing the original for the details it contains. Your own plot is displayed as you move, allowing for feedback and correction. (Unfortunately our copy of Figure 4 is too faint to reproduce directly - what you see here has had to be emboldened by pen.)

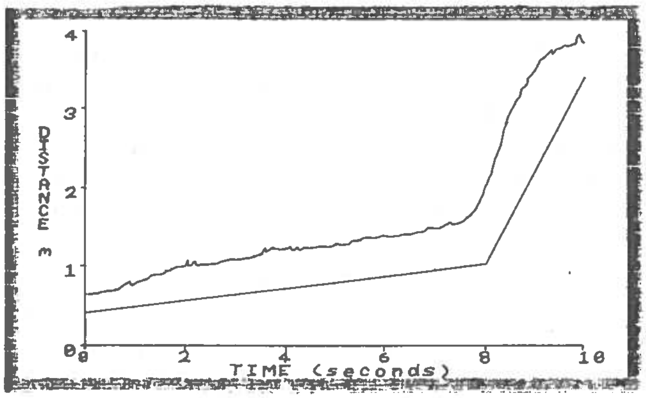

Fig.4 - Practice makes perfect!

One commonly found facility is absent from the software: it does not let you save data on disc. We think it should.

Verdict

An excellent product of considerable educational merit. We particularly like the interactive nature which extends the scope for learning through practical work beyond that which is feasible by traditional means.

After the Master - Which computer?

The Master is of course still available. Why are we considering 'the next' machine at all? The new generation of machines give you more computing power for your money; but do you need more computing power? The other possibility would be equal power for less money, but for our applications in Technology and Science, where the interfaces may be a large part of the cost, this is not in practice available.

You may not need more computer power - can we honestly say we need computers at all? - but there are all kinds of educationally useful things we can do with it. Or there would be, if the software existed - and here we come to the crux of the matter. At present, the Master (or Model B) is far and away the most useful computer in schools, because it has the most extensive base of educationally useful software.

None of the new generation of machines have one percent as much - wild claims to the contrary notwithstanding. Most of them try to achieve some degree of compatibility in order to graft their own growth to the stock of the BBC.

Their position is, "as of now, you can run all your old BBC software on our machine; when it dominates the market, new software will appear which takes advantage of its greater power".

This is pure hype. The art of IBM cloning is now well established, but no one has even tried to clone a Model B or a Master. Acorn's own emulator is good enough to be useful to anyone converting old BBC programs to run on the Archimedes - but not so good that you can expect much software to run without a bit of hacking. No one else's emulator even comes close. The fact that a machine has BBC BASIC (or a close facsimile) is almost completely irrelevant to the question of software compatibility.

Nonetheless, much of the existing base of software will be rewritten, perhaps with enhancements, to run on any or all of the new machines. It still takes much less effort than designing brand new software from scratch. Acorn's emulator means that the Archimedes will undoubtedly remain a long way ahead in this particular race. Unfortunately the quality of the conversion is not always high - the size of the market perhaps doesn't justify the amount of effort required to ensure that the new version works properly throughout.

Whenever we buy any equipment, we should first consider the purposes for which we are buying it. That may sound obvious, but it is astonishing how many people select equipment first, and then start to think how to apply it to their purposes.

For what do we use computers in science and technology? The primary applications must be data logging, and control of experiments, models, or equipment. Data analysis is also very important. There are computer aided teaching packages in science and technology, as in other fields; but in our opinion their value is at best small compared with the value of using computers in practical work.

For data logging and control, the all important consideration is the availability of interfaces. The beauty of the BBC 'B' and Master was that the necessary interfaces were built in. That is true of none of the current generation of micros.

Appropriate interfaces have been available for IBMs and compatibles for some time, but the prices have been high for schools. The software has been aimed at research and industrial users, not secondary education. The prices of these interfaces are beginning to come down, but software is lagging behind. Catch-22: there are few if any IBM compatibles in school labs and workshops, therefore it isn't worth writing software for them, therefore no-one will get one. But this is the same for all the new generation of computers.

GET ANOTHER MASTER?

This is a fairly safe move. You have all the software you need for the courses you are running, or can foresee so far. The machine is cheap, considering that it has good interfacing facilities built in. Your only slight worry is that you'll miss out on marvellous new software for the new machines.

IBM COMPATIBLE?

But which one? Never mind the manufacturer, think about the specifications. 256Kbyte? 512Kbyte? 640Kbyte? Monochrome, EGA, or VGA? (see footnote at end). 8088, 80286 or 80386? The possibilities are endless. You can't afford a 4Mbyte 80386 with VGA and a hard disc. Even if you can, no-one will write school software that utilizes the beast because yours will be the only one. They will write for the cheapest combination because then it will work on anything. This is no improvement on a Master - and considerably more expensive, taking the interfaces into account. Except at the expensive end of the range, the technology is the same vintage as the Master. There is little doubt that your hardware will continue to be supported, but you may have difficulty finding much suitable software, at least in the short term.

APPLE MACINTOSH?

This has always been an expensive choice, and it is beginning to be left high and dry. Direct control of, and access to, electronic signals is not easy on a Macintosh, unlike early Apples; there is consequently a dearth of interfaces and their software. This machine is firmly entrenched in Scottish schools providing DTP (desk top publishing) facilities.

NIMBUS?

Nimbuses are much more expensive than Masters. They are fairly well supported with software and interfaces, and likely to continue to be supported for quite a while. Like IBM compatibles (which they aren't), and Masters, they are based on old technology - not so much more up-to-date, as more up-market.

ATARI? or AMIGA?

These are also not much more up-to-date technologically, and they are not very well supported with interfaces and their software.

ARCHIMEDES? (or ACORN A3000?)

Outstandingly the most advanced design on the market, the Archimedes is RISC technology - a Reduced Instruction Set Computer. High-price manufacturers are only just beginning to produce such designs; no other manufacturer at the low-price end of the market has even begun work on one. Of course there are more powerful machines on the market - at ten times the price of an Archimedes, or more - based on lots of expensive old technology rather than a little of the new. Acorn's remarkable technological lead enables them to offer very much the most powerful machine at any reasonable price.

This extra power would be irrelevant if software or interfaces were going to be a problem. This is always a dilemma with new machines, but that is no excuse to stagnate. There are less doubts about Archimedes in this respect than about any other machine on the market. The same interfaces that work with the Master and Model B work with the Archimedes - but you will need an 'I/O podule'.

Originally the Archimedes appeared in three versions, the A305, the A310 and the A440. These are now being superseded by the A3000, the A410, the A420 and the A440/1. The A3000 is much the cheapest, and has all the features you are likely to need.

SO?

The A3000 should be the workhorse of secondary school computing for the next few years, in much the way the Model B has been for the last few. This is particularly so in science and technology, where the (dubious) advantage of being able to run (obsolescent) industry standard business software is of no relevance. DTP is one application relevant to science and technology where Acorn may still have to concede to Apple. The DTP software for the Archimedes and A3000 is arguably better, but there is a large amount of existing material which can only be edited on Apples - unless or until it can be interpreted by Acorn software. Most people who are likely to want to edit such material probably already have access to an Apple - but for use in a lab or technology room, certainly don't handicap yourself with an Apple just for the sake of DTP.

YET . . .

The microcomputer market suffers from the instability of positive feedback. If a particular machine gains a slight advantage in perceived market position, this is amplified as software houses switch to writing for it. Similarly, a small setback may be amplified as they switch to other machines.

The A3000 should ....Famous last words! Crystal ball gazing is notoriously dangerous at the best of times. The best horse is the most likely to win the race, but no one can ever be sure.

Footnote:

* CGA, EGA & VGA - IBM's Colour Graphic Adapter, Enhanced Graphic Adapter and Video Graphic Array for colour output to appropriate monitors. VGA is higher quality than EGA, which is better than CGA.

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Trade News

Changes of address

The Weir Electrical Instrument Co. Ltd., makers of power supplies, meters and other instruments, have recently moved from their old Bradford-on-Avon factory to a new site elsewhere in Wiltshire. Please refer to the inside cover for their new address.

Some of you may know the Adam McNaughton song about the family that that was threatened with banishment tae greenbelt's freezin floors, but in the nick of time flitted "tae the buildin facin oors across the road". The Scottish Electronic & Calibration Company are at it again - if you pardon the expression - that is, flitting. Having come into town from the freezin floors of Neilston they have recently moved from one to a neighbouring unit in their Dalmarnock industrial estate. Their new address is on the inside cover.

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SURPLUS EQUIPMENT OFFERS

Griffin and George Items

Through the generosity of Griffin and George we are able to offer a range of unused equipment, visual aids and materials. These are mostly 'ends of lines' which Griffins have cleared out of their warehouses. They are all items which have been removed from the catalogue either because they are no longer stocked or because they have been replaced by updated versions.

These Griffin and George items have been assigned specific item numbers prefixed GH, GM or GS to distinguish them from our own stock items. Because these materials have been donated the prices shown are largely nominal. Except for some heavy items most of the prices include any post and packing charges, otherwise the charge reflects only our handling, cataloguing and sorting costs.

Please note: Once they had written off these goods and passed them to SSERC, Griffin and George ceased to be responsible for any faults or any required repairs. Should you be lucky in the ballot we will ask you to identify the goods in your stock or inventory list as SSERC supplied. Please direct any subsequent complaints or queries to us and not to Griffin and George Ltd.

SSERC Items

Before the move to our new premises we took the opportunity to sort through some of our own stock. Much of what we saw as no longer useful was cleared out. There were however a number of bits of apparatus and equipment for which we no longer have any need, but schools would readily find a use.

A number of such items are listed after the Griffin materials and have numbers prefixed with "SH". Such items obviously are used, not new. We give no guarantee as such with these but, as past customers may know, we aim to please. We will take back goods and refund monies in cases of genuine dissatisfaction because of faults etc.

General Conditions

In general this offer is subject to the conditions laid down in Bulletin 158 (October 1987). All G&G and SSERC items are **subject to our ballot procedures.** Entries should preferably be submitted on a postcard and with an indicated order of priority.

Griffin Items

Hardware - equipment and materials

Item GH1	Pond liner, butyl, 2.4 x 2.4 m.	£12
Item GH2	As above but much larger actual area unknown.	£20
Item GH3	Pond filter, by Lotus, 330 gallons per minute capacity, 0.5 and 0.75 " hose connections.	£1
Item GH4	Museum mount jars, clear plastic with lid.	30p
Item GH5	Camboard Electronics Kit A suitable for upper primary, lower secondary stages.	£2
Item GH6	Sectional, working model of an hydraulic brake system with two variants : single and twin leading shoes. For use with O.H.P.	£10
Item GH7	Rotring precision drawing compass with mount to take drawing pen.	£3
Item GH8	Soil sieves, coarse and fine each: (Nos.60, 22 & 200 state preference).	£2
Item GH9	Rose head drill bit in high speed steel for countersinking -½"x90°.	30p
Item GH10	Set squares, 45/45/90 pack of 5.	£1
Item GH11	Soil core sampler, spatulate not auger type.	£2-50
Item GH12	'T'-square in beech.	50p
Item GH13	Spring scale by Ohaus circular dial type, scaled 0-20 x 10 g.	£1-50

Models and related items

Item GM1	Geological landform models. Pupil sets of 4 different vacuum-formed models, with booklet.	£3
Item GM2	Anatomical model kit, male. ('Visible Man').	£4
Item GM3	Miniature model of human spinal column.	£5
Item GM4	Water cycle model by Hubbard.	£3
Item GM5	Sectional model of human foot. Life-size and showing arched condition.	£5
Item GM6	Clam model. Vacuum-formed with various sections mounted on a wall plaque ca.40 x 60 cm.	£2
Item GM7	Dinosaur model kit: Pleisiosaurus.	£3
Item GM8	As above: Tyrannosaurus.	£3
Item GM9	As above: Brontosaurus	£3
Item GM10	Liver model on stand (one-piece labelled model, not dissectable).	£2-50
Item GM11	Pancreas model on stand, with part of stomach and kidney attached.	£4
Item GM12	Stomach model. Demountable (2 sections).	£5
Item GM13	Female pelvis, negroid model. Sectional and demountable.	£15
Item GM14	Snail specimens, aquatic and terrestial in glass fronted case.	£5
Item GM15	Fossil cast of Dorygnathus	£3

Charts, books and visual aids

Item GS1	"Biology : Functional, Systematic and Environmental". by Thomas & Thomas.	£3
Item GS2	"Life Science" by P.D.Riley	£2
Item GS3	Ecopack 1 on woodlice, with work-sheets and slides (as a strip and frames).	£2
Item GS4	Kidney chart - colour of good quality mounted on roller and bar.	£5
Item GS5	As above: The Male Pelvis.	£5
Item GS6	As above: The Female Pelvis.	£5
Item GS7	Job-lot - "Wood Technology" charts. Part set only - timber sections, plywood and structure	£1
Item GS8	"Bony fish",raised coloured chart showing skeleton, jaws and heart. With key.	£2-50
Item GS9	As previous item, "Insect Types"	£2-50
Item GS10	As above but no key.	£2
Item GS11	Set of posters on "Farm Animals" cattle, sheep, poultry and pigs.	£2-50
Item GS12	Poster of caterpillars of British butterflies.	£1
Item GS13	'Write-on' chart "The Stem" (dicot.), laminated black and white outlines.	£2
Item GS14	As above - "The Earthworm".	£2
Item GS15	Coloured chart on anatomy of Domestic Fowl.	£2
Item GS16	As above - Frog.	£2
Item GS17	As above - Perch.	£2

Item GS18 Coloured chart "Human Brain", laminated. £3

Item GS19 Set of 35 mm colour slides on "Harmful Insects" (9 species). £1-50

Item GS20 As above. "Life History of the Desert Locust" (12 slides). £2-00

Item GS21 As above. "Plant Parasites" set of 20 slides with copious notes. £3

Item GS22 35 mm filmstrip (photographs not diagrams) on "Glassmaking", with notes. £2

Item GS23a 35 mm colour slides (set of 12) on "The Potato" with short notes. £2

Item GS23b As above. "The Sunflower" £2

Item GS24 As above but set of 40 slides in the "Earth, Ice, Fire and Water" series. "Sedimentary Environments and Rocks". In black plastic wallet with notes. £4

Item GS25 35 mm colour slides "Physics in the Modern World" series."Optical Instruments" (12 slides in wallet with notes. £2-50

Item GS26 As above but "Electromagnetic Optics 1" (radar, microwaves etc.) £2-50

Item GS27 As above but "Engines used in Transport 1". £2-50

Item GS28 As GS27 but "Engines used in Transport 2" £2-50

Item GS29 Set of 12 colour slides in the "Advanced Physics" series. "The Hydrogen Atom : Energy Levels". £2-00

Item GS30 As above. "Introduction to Lasers" £2

Item GS31 As above. "Gas Lasers". £2

Item GS32 Set of 25, 35 mm colour slides on "Pteridophyta". £3

Item GS33 Set of 8 slides by Gene Cox on "Locomotion in very small organisms". £2

Item GS34 Set of 8 slides and notes "Cockroach A". £2

Item GS35 As above but "Insects from different groups. £2

Item GS36 As above "Flowering Plants, Stems part B". £2

Item GS37 As GS36 but part C (secondary thickening). £2

Item GS38 Set of 30 colour slides on mammalian skeleton and teeth.
One mint condition at : £4
One scruffy at : £3.

Item GS39 Set of three wallets of slides on "The Threat of Nuclear War": "Nature and Effects"; "Offence, Defence" and "Nuclear Strategy". £5

Item GS40 O.h.p. transparencies. Job lot including : evolution of horse, egg and chick embryo, tapeworm etc. £2

Item GS41 As above but different assortment by Hagemann with a few titles duplicated. £5

Item GS42 Set of b & w o.h.p transparencies in series to accompany earlier editions of "Introduction to Biology" by Mackean. "Insect Locomotion" includes "Flight 1 & 2" and "Walking". 6 slides in all plus notes. £3

Item GS43 As above but "Human Anatomy - Teeth 2". £1

Item GS44 Video, VHS, 50 minutes, "Casual Encounters of the Sexual Kind". (Offered unseen). £5

Item GS45 Book : "The Complete Field Guide to British Wildlife". Arlott et.al. Pub. Collins. 1986 reprint of the 1981 edition. £2

Item GS46 Book : "A Field Guide to the Reptiles and Amphibians of Britain and Europe". Arnold & Burton. Pub. by Collins. 1980 reprint of 1978 edition. Hardback. £3-50

Item GS47 "Handguide to the Trees of Britain and Northern Europe". Wilkinson & Mitchell. Collins 1980 reprint of 1978 edition. £2

Item GS48a Study Guide "Advanced Biology" by C.A.Clegg. Pub. PAN books 1982. £2

Item GS48b As a but "Human Biology" 1 only £1-50

Item GS49 "Physics for Today and Tomorrow" Tom Duncan, 2nd edition. Pub. John Murray. £2

Item GS50 "Physics. A Textbook for Advanced Level Students". Tom Duncan. Pub. John Murray. £3

End of Griffin Items

SSERC Items

Item SH1 Spirometer with accessories, old pattern with narrower breathing hoses. 'Nuffield' pattern bag type spirometer also included. Plus carriage. £30

Item SH2 Wormery, Rothamstead pattern. (Callers only). £2

Item SH3 Sphygmomanometer by Accoson. Aneroid type, circular dial 2" dia. £8

Item SH4 DNA/RNA Molecular model kit by Biobits. Used and scruffy thus p.& p.only. Free

Item SH5 Models of various human joints: elbow, hip and atlas/axis. £3

Item SH6 Centrifuge, student type, swing-out head 4 tube holders. Micro-switch in lid and biassed-off mains switch. Tested recently earth and insulation. Plus carriage. £5

Item SH7 'Data' sensors assorted. Most old Harris 'Data Memory' pattern with 0-1 V output. Light; temperature; electronic arm; oxygen and pH. No electrodes for last 2 and no external light probe just built-in sensor. Price is for the lot. £5

Item SH8 Small flow tank for use on o.h.p. For investigating streamlining etc. Hand-operated paddles. Plus carriage. £1

Item SH9 Egg-incubator. Commercial model Polystyrene chamber with SSERC-added protective blockboard casing. Plus carriage. £5

Item SH10 'Nuffield' pattern, environmental chamber/locust cage. Needs egg tubes. Plus carriage. £10

Note that: In an attempt to guard against purchase for personal use, we will only sell items SH11 to SH17 inclusive against official orders. All microscope prices are exclusive of any carriage charges.

Item SH11 Microscope, M10A by Vickers, to SSERC 'H' grade spec. £25

Item SH12 Geological microsope, circular rotating stage, polariser and analyser etc. £25

Item SH13 Microscope, Hori-Abbephase type by Swift. To 'H' grade spec. £30

Item SH14 Microscope, Chinese, traditional open-horseshoe foot, inclinable stand. £30

Item SH15 Microscope, Polish, CMZ, to 'H' grade spec. £30

Item SH16 Microscope, Beck Student. Non-RMS standard objectives. S1/S2 spec. 'S' grade at a push. £15

Item SH17 Microscope, by C.& D. Made to our old 'O' grade spec. Functional but old fashioned. Hence price. £10

End of ballot section

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Non-ballot stock items

Please note that items are not necessarily arranged according to the item number. They may be grouped because of similarity of application, or for other reasons. Often the item number serves only for stock identification by us in making up orders. Please also note that you will be charged for postage.

Motors

Item 590 Stepper motor, single phase, 5 V manufactured for clock or other timing device. Delicate gearing with 40 tooth plastic wheel as output. Suitable for demonstration, or as a method of digital input for control or timing. Unidirectional. Dimens. 30 x 25 x 10 mm. Circuit diagram supplied. £1.20

Item 591 Stepper motor, 4 phase, 12-14 V d.c., 400 mA, 27.5 Ω coil. Step angle 7.5 degrees. Powerful motor with 15 mm, 6 mm dia. output shaft. Dimens. 40 mm long, 70 mm diameter on 70 mm square mounting plate with fixing holes at 56 mm centres. Circuit diagram supplied. £4.50

Item 626 Precision motor, 0.5-15 V d.c., power output 2.2 W, no load speed & current 7700 rpm, 16 mA, stall torque 11 mN m, 34 mm long, 23 mm dia., output shaft, 14t.steel pinion. £3.80

Item 627 Precision motor tacho unit, consists of motor unit with integral generator. 0.5-15 V d.c.. 55 mm long, 24 mm dia., output-shaft 10 mm long, 3 mm dia.. £5.50

Item 628 Precision motor, 0.1-12 V d.c., no load current & speed, 18 mA 5200 rpm, stall torque 46 mN m, 40 mm long, 28 mm dia., output shaft 8 mm steel spline. £3.50

Item 594 Precision motor, 0.5 - 12 V d.c. no load current and speed, 12 mA 4900 rpm, stall torque 29 mN m, 48 mm long, 23 mm dia., output shaft 10 mm long, 3 mm dia. £3.50

Item 592 Miniature motor, 2.5 to 9 V d.c., smooth running, speed governor. No load current 30 mA. Dimensions 35 x 40 mm dia. 8 mm shaft 2 mm dia. 60p

Item 593 Miniature d.c. motor, 1.5 - 3 V No load current 60 mA, speed 4,500 - 3,700 r.p.m. Stall torque 7 mN m. 30.5 mm long by 23 mm dia. 5 mm x 2 mm dia. shaft. 35p

Item 621 Miniature d.c. motor, 1.5 - 3 V Open construction, ideal for demonstration. Dims. 19 x 9 x 18 mm, double-ended output shaft, 5 mm x 1.5 mm dia. 20p

Item 395 Model maker's motor, 3 V d.c. no load speed & current: 6250 rpm, 350 mA. Stall torque 1 mN m. Dimens. 35 mm long and 30 mm dia. with 15 mm shaft 2 mm dia. Small magnet in base for easy mounting. 40p

Item 625 Worm and gear for use with miniature motors. Brass worm with plastic gear wheel. 35p

Item 378 Encoder disk stainless steel with 15 slots, 30 mm dia. with 4 mm fixing hole. 75p

Item 642 Encoder disk stainless steel with 30 slots, 30 mm dia. with 4 mm fixing hole. £1.30

Miscellaneous items

Item 629	Dual-tone buzzer with flashing light, mounted on small P.C.B. The unit has a PP3 battery clip and two flying leads for switch applications.	40p
Item 643	Solar cell with motor. Cell area 45 x 75 mm, output 0.45 V max., 400 mA. The motor operates with a no load current of 250 mA.	£2.50
Item 313	Thermostat, open construction, adjustable, range of operation covers normal room temperatures. Rated at 10 A, 250 V but low voltage operation also possible.	60p
Item 380	Thermostat, with capillary 500 mm long. Operates at low voltage but rated 10 A, 250 V. Can be activated by heat from human hand.	£1.25
Item 385	Pressure switch, operable by water or air pressure. Rated 15 A, 250 V (low voltage operation also). Dimensions 3" dia. x 2".	65p
Item 419	Humidity switch operates by contraction or expansion of membrane. Ideal for greenhouse or similar control project with items 348 and 344.Rated 3.75 A up to 240 V.	75p
Item 507	Optical fibre, plastic, per metre single strand 1 mm dia. Used for the optical transmission of sound. See Bulletin 140 for one such application.	40p
Item 612	Beaker tongs, metal, not crucible type, but kind which grasps the beaker edge with formed jaws.	£1.20
Item 348	Submersible pump, 6 - 12 V d.c. Corrosion free nylon construction.	£6
Item 322	Germanium diodes	8p
Item 371	Ferrite rod aerial, two coils MW & LW, dimens. 10 X 140 mm.	40p
Item 511	Loudspeaker, 8R, 2 W, 75 mm, resonant frequency 250 Hz.	50p
Item 333	Microphone inserts, high impedance, 23 mm dia. 12 mm depth	40p
Item 631	Microswitch, miniature, SPST, normally closed, push to break. 40 mm long actuating arm, 4 mm spade connections. Dims. 20 x 10 x 16mm.	25p
Item 632	Microswitch, standard, SPST, normally closed, push to break. 28 mm long angled actuator arm. Dims. 27 x10 x 16mm.	25p
Item 354	Reed switch, s.p.s.t., 46 mm long	10p
Item 508	l.e.d.s, red, green, yellow: each or 10 for	6p 50p
Item 645	Ceramic magnets, assorted sizes and shapes	7p
Item 344	Electric fan, 12 V, ex-motor car.	£4.50
Item 429	Metallised polyester film, one square metre, 12 microns thick (see Bulletin 139 for applications)	£1

Resistors fixed & variable, components

Item 328	Potentiometer,wire wound, 15R linear, 36 mm dia.	20p
Item 329	As above but 33R.	20p
Item 330	As above but 50R and 40mm dia.	20p
Item 331	As above but 100R and 36 mm dia.	20p
Item 421	d.i.l. resistor networks per 10 following values available: 62R; 100R; 1K0; 1K2; 6K8; 10K; 20K; 150K; 125/139R and 1M0/6K0	30p

Item 420 5% carbon film, ¼ watt resistors values as follows: 10R; 15R; 22R; 33R; 47R; 68R; 100R; 120R; 150R; 180R; 220R; 270R; 330R; 390R; 470R; 560R; 680R; 820R; 1K0; 1K2; 1K8; 2K2; 2K7; 3K3; 3K9; 4K7; 5K6; 6K8; 8K2; 10K; 12K; 15K; 18K; 22K; 27K; 33K; 39K; 47K; 56K; 68K; 82K; 100K; 150K; 220K; 330K; 470K; 680K; 1M0; 2M2; 4M7 & 10M. — 6p/10

N.B. If anyone is interested in purchasing other values in the E12 range between 1R0 and 10M, which are not listed above, please let us know so that we can consider extending our stock list.

Item BP100 Precision Helipots, Beckman mainly 10 turn, many values available. Please send for a complete stock list. — 10p to 50p

Item BP2017 Precision Helipot, Beckman 1D kΩ, 10 turn, 6mm dia.shaft — 50p

Sensors

Item 615 Wire, for thermocouples, 1 m of each of 0.5 mm dia. Chromel (nickel chromium) and Alumel (nickel aluminium). Makes d-i-y thermocouple - see Bulletin 158. — £2

Item 633 Infra-red sensors, emitter and detector, spectrally matched pair. Data sheet supplied. Priced for pair. — 45p

Item 640 Disk thermistor with flying leads, resistance at 25°C 15 kΩ. — 30p

Item 641 Precision R-T curve matched thermistor; for use in physiology, micrometeorology, or any work requiring an accurate or miniature sensor — £2.60

Kynar film items

See Bulletin 155 for details of applications such as force/time plots and detection of long wave infra red radiation.

Item 502 Kynar film, screened, 28 um thick, surface area 18 x 100 mm. With co-axial lead and either BNC or 4 mm connectors (please specify type). — £20

Item 503 Kynar film, unscreened, 28 um thick, 12 x 30 mm, no connecting leads. — 55p

Item 504 Copper foil with conductive, adhesive backing, 1" strip. Makes pads for Kynar film, to which connecting leads may be soldered. — 10p

Item 505 Sensifoam, 0.25" thick, 6" X 6" — £1.00

Item 506 Resistor, 1 gigohm, ¼ W — £1.00

We also hold in stock a quantity of other electronic components. If you do have requirements for items not listed above please let us know and we will do our best to meet your needs, or to direct you to other sources of supply.

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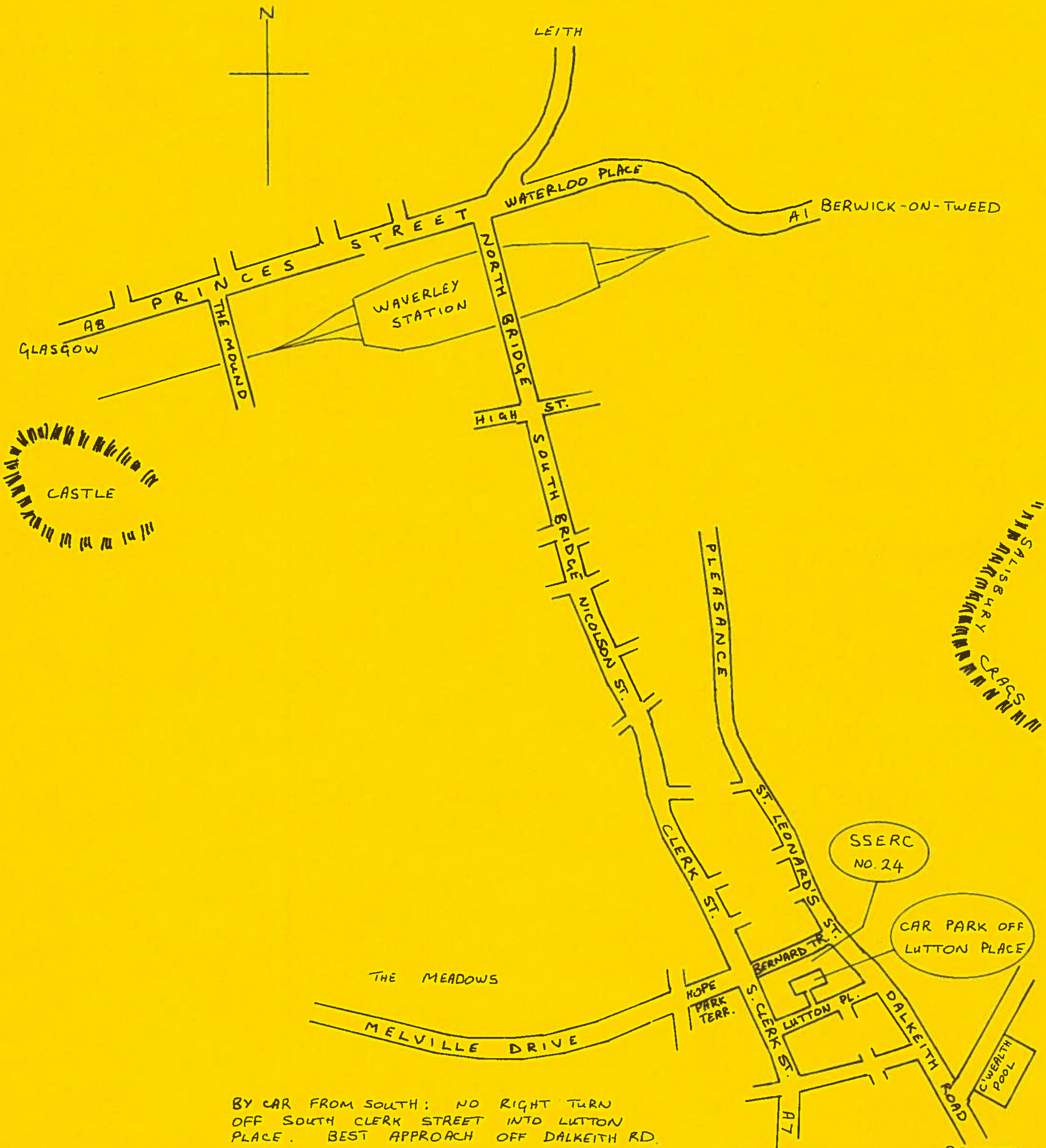

BY CAR FROM SOUTH: NO RIGHT TURN OFF SOUTH CLERK STREET INTO LUTTON PLACE. BEST APPROACH OFF DALKEITH RD.

"Our new location"

S.S.E.R.C.

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