

# Computer Education

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One thousand copies of this issue have been printed.

"Computer Education" is typed and assembled by staff of the Enfield College Computing Centre.

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EDITOR'S NOTES

This issue is devoted mainly to the subject of computing hardware. We hope that this will be interesting to those at all levels of education and training. The report of Working Party No. 4, of the B.C.S., is nominally for schools, but in fact some of the units described are widely used in technical colleges, universities and military training establishments.

Recently we have heard several pleas for an official body to issue equipment evaluations for education in the computer field and we hope that the C.E.G. will be able to fill this obvious gap. In later issues we may be able to move into the more complex area of evaluation of full-scale digital computers.

Although it represents a minority viewpoint, the article about a second-hand computer installation provides a worthwhile contrast. The obvious question of cost, both capital and running, has not been answered in this report. We also wonder how more productive the staff involved in this school project might have been if modern facilities were made available.

Following the A.G.M. at the end of April there has been another change of editor in the Computer Education office. Mr. John Abrahams is moving to Canada and his place is being taken by Mr. 'Bob' Bowker.

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## "Analogue/Hybrid Computers for Education and Research"

by J.R.Abrahams and J.D.Cumbers (Enfield College Computing Centre)

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### Educational Requirements

The educational value of analogue and hybrid computers is more widely appreciated in Britain than in other countries, with the result that some manufacturers have this market very much in mind. Educational equipment requirements divide into three clearly defined levels, as follows:

- a) Simple analogue computers, for school and further education use, primarily as a teaching aid in mathematics and science. For this purpose it is difficult to obtain much money and is really not necessary to spend more than £500 per computer. In our opinion this is now the only field in which the straightforward analogue computer, without hybrid facilities, has any relevance. At the same time the simple analogue computer, typically with four amplifiers, should incorporate the best of modern practice in its components and its controls and, for absolute safety with unskilled occasional users, be a 10V machine. In other words, we are convinced that there is now no place at all for the computer having thermionic valves or one costing over £500 which does not have some hybrid facilities.
- b) Small analogue-based hybrid for undergraduate use. Ideally each university and polytechnic should have several machines in this class, costing in the range from one to five thousand pounds each. A prime requirement here is for a large clear patchboard, preferably of the removable type, and for a reasonable complement of patchable digital logic units. A capacity for up to 24 amplifiers, 3 multipliers, 2 function generators and some 30 potentiometers would seem desirable, with a component accuracy of about 0.2%. It is surprising that there is only one computer to meet this general specification on the market (System Computers' TAG 30) and this becomes rather too expensive when the logic is included. The undergraduate need might be met by having several patchboards for a larger computer or by linked versions of the small teaching aids, but both of these solutions are very much second best.
- c) Medium-sized hybrid for research and project use. The universities and polytechnics with a strong interest in engineering or computer science can justify the purchase of a hybrid computer for postgraduate research and final-year undergraduate projects. At this time there are, perhaps, six such machines in higher education and we would expect to see this to grow to twenty by 1971.

We are considering in this category machines which start at around £10,000 minimum and can grow to £100,000, in some cases, with full hybrid facilities, although we would expect the average installation to stabilize at around £40,000. It is this class of computer in which industry is most interested and we can, therefore, expect the present software and interface difficulties to be solved over the next two years. One problem at this level is of planning the economic growth of the hybrid computer, and manufacturers differ widely in their approach to this question. With one type of computer an expenditure of £12,000 will buy only the shell, without a single amplifier, while another firm can supply a usable computer for £6,000, which can still grow to a full hybrid with over 120 amplifiers.

### Facts and Figures

We are grateful to the manufacturers and experienced users who supplied most of the information, and some constructive criticisms, for this report. The various computers have been classified in a number of price brackets, at roughly logarithmic steps. All the prices given here are correct at June 1968, and include import duty, where this is applicable. In some cases it may be possible to claim duty draw-back, for educational and research establishments. Alternatively a few manufacturers, such as E.A.L. and Lan-Elec, give an educational discount, typically of 5%, in lieu of duty refund. The addresses of all the companies known to be interested in the British analogue/hybrid computer market are given at the end of this article.

#### 1) Analogue Computers under £200

In the small, specialized, analogue computer market it is just not possible to produce a totally satisfactory unit selling in this price bracket, which is therefore best avoided, if possible. This advice is obviously unrealistic for the many potential school purchasers, who must consider the features of the available low-cost computers carefully. It is significant that no company which is really committed to the analogue computing business produces a unit in this class.

The Heathkit EC-1U uses thermionic valves and was introduced as a British-made unit some three years ago, at £97 8s as a kit, or £122 fully assembled. It has nine low-gain amplifiers, which are liable to instability, five potentiometers and three initial condition supplies. Feedback components have to be plugged into the front of the cluttered patch panel. The Heathkit analogue computer is in use at a number of technical colleges and a few schools.

The new C40 analogue computer from Physical and Electronic Laboratories appears to offer more than its competitors, at £119. There is a limited ratio of only two potentiometers to four amplifiers, each amplifier having a gain of over 20,000 times and a reasonably low drift rate. Any amplifier may be used as an integrator

or Summer, using built-in components, and the repetitive operation control has a very wide frequency range. There is no Hold control and the low output current available from each amplifier may lead to problems in some patching configurations.

Another new teaching aid is the Peta II from Westinghouse, at a price of £176. This has four encapsulated amplifiers (gain not stated) and two potentiometers per amplifier. Each amplifier may be used for integration or summing, with components having a 1% accuracy. It appears that there are no Hold or Manual controls, and that the computer can only be operated under fixed repetitive conditions of five seconds for compute time and one second for reset.

As both the C 40 and Peta II are new designs there is no indication how reliable these computers will prove under intensive class-room use.

A simple four amplifier teaching aid is sold by A.M.Lock and Co. Ltd. This has many features in common with an obsolete valve computer originally made by F.C.Robinson, since both were designed at the Manchester Institute of Science and Technology, primarily for the teaching of servo-mechanisms. This Lock Teachaid has only two potentiometers, a front panel layout which is not very flexible, and no provision for initial conditions or Hold mode. The 10 V amplifiers have a gain of 1,000. In the repetitive mode the fixed frequency of operation is 25 c/s. The price of this unit is £124.

## 2) Analogue Computers under £1,000

This may be considered as the technical college range, with four machines available from three manufacturers. Lan-Elec offer two versions of their Lan-Alog 4 computer, each having four solid-state 10V amplifiers, with an open-loop gain of 50,000, a thermal drift of less than  $10\mu\text{V}/^\circ\text{C}$  and passive components are matched to within 0.2% at each stage. There are six single-turn potentiometers and a centre-zero meter with three voltage ranges. Each amplifier can be used for integrating or summing, with built-in components, and there are controls for repetitive and slave operation, with hold facilities. The basic La-4 costs £229, or the LA-4R, with one ten-turn dialpot is £245, and the separate twin power unit is £70. Lan-Elec also sell an add-on unit, (LA-4M) with three summing amplifiers, one high-quality multiplier and five potentiometers for £280. The computer and multiplier panels, together with power unit and desk-top cabinet, are also sold as the LA-8 computer prices at £620. The Lan-Alog computers have been available for three years and are, by far the most widely used transistorized small analogue computers.

System Computers Ltd. is a subsidiary of International Research and Development Co. Ltd., whose parent company is C.A.Parsons, an entirely British organization.

System Computers have at last announced a transistorized Analogue Tutor (Mark 3) with six amplifiers, each with an open-loop gain of more than  $10^6$ . Of these six amplifiers, four are dual-purpose and two are available only as summers. There are eight potentiometers and provision is made for an optional mark-space multiplier. Another feature of the instrument includes slaving, which allows two or more tutors to be inter-connected for larger problems. The tutor, complete with a set of patching components and leads, is £490 and the optional multiplier is £75.

Solartron are now owned by an American company, but continue to design and manufacture analogue and hybrid computers in this country. The Solartron Analogue Tutor was the most popular of all analogue computers, but is now physically too large and also too expensive for its purpose. This Tutor has six chopper-stabilized thermionic-valve amplifiers, four of which are dual-purpose, with a gain of  $10^6$ . There are eight 10-turn potentiometers, a centre-zero meter and a small removable patchboard. A separate power unit, which can supply up to four Tutors, is required. The Solartron Analogue Tutor costs £660, plus another £225 for the large power unit.

### 3) Analogue/Hybrid Computers under £6,000

In this group are five computers which can be put to useful research and development work in many fields in addition to undergraduate education. The first four are 10V machines. We feel that this is the range which now offers the best commercial prospects to a manufacturer who is fully aware of educational needs. Electronic Associates have very recently announced a new desk-top analogue/hybrid computer, the model 380, which fits into this range. The 380 can accommodate up to 36 ten-volt amplifiers, 32 potentiometers, 12 And gates, with a variety of non-linear and other parallel logic elements. Prices for the E.A.L. 380 will lie between £2,385 and £12,000. The amplifiers in this computer have a gain of 3,000, at 1kHz, and a 3dB bandwidth of 100kHz, when used as a summer. This attractive machine is effectively a replacement for the TR-20, of which 68 have been delivered in the U.K. The TR-20 can have up to 24 amplifiers and 32 ten-turn potentiometers, with prices between £1,800 and £5,000, but no facilities for digital logic. In both the 380 and the TR-20 the computing components have an accuracy of 0.01% and there is a large detachable patchboard occupying most of the front area of the computer.

Computing Techniques are a completely British company who have successfully developed a range of encapsulated operational amplifiers and digital circuits, against strong competition from several larger American companies. These modules are employed in their Vidac 336 analogue/hybrid computer, which breaks new ground in several of its features. The full Vidac 336 can have six integrators, three summers, three free amplifiers, one comparator and a number of other units. The logic complement includes three flip-flops, four gates and three inverters. There are 12 potentiometers, of which

nine are tied to signal ground. All the integrator controls are available, so giving full logic-controlled hybrid capability. There is the choice of 1% or 0.1% passive components and the Vidac 336 has a small low-cost removable patchboard. We are not sure that the amplifier (with a gain of about  $2 \times 10^4$ , an output current of 5mA and a -3db bandwidth at 1kHz) is good enough for this class of computer. The price of the Vidac 336 is basically £695 without any amplifiers, £1181 with 12 amplifiers and would be over £2,000 when fully equipped.

The TAG 30 computer from System Computers has a large two-row removable patchboard accomodating up to 26 modules. 20 positions are available for integrators, summers and multipliers. The other six positions allow for a wide range of non-linear units, the potentiometer "marshalling panel" (up to 20 coefficient potentiometers in TAG 30) and several modules incorporating asynchronous logic circuits employing high-speed integrated 10-volt DTL circuits. Clearly it is difficult to fit much logic, in this computer, and the manufacturers only recommend this in the multi-console versions. A basic TAG 30 with 10 amplifiers (two committed to two multipliers) costs £3,222 and the full machine, give 16 summer/integrators and five two-input summers is £5,550. There is no evidence that System Computers have any experience with the larger hybrid computers.

Solartron now offer a very comprehensive range of machines, having previously lagged behind their American competitors, which offer compatibility of modules up to 300 amplifiers, although the unit construction is such that a small computer cannot "grow" into the next step in the range. The TY 1451 still has thermionic valve amplifiers, with solid-state choppers, as in their Analogue Tutor. It is in a cabinet 54" high by 22" wide and has a push-button addressing system to monitor outputs from the 24 amplifiers and 24 potentiometers. The basic 12 amplifier Linear TY 1451 configuration is £2,250 and the full 24 amplifier Non-Linear system is £3,750. A standard logic expansion unit is available at £750, and this could then make a useful hybrid machine for educational purposes. The smallest machine in the Solartron Hybrid 7 range is the transistorized version of the TY 1451, with 100V amplifiers, and is known as the HS7-1. This computer includes the logic facilities as a standard feature, and the cost of a 24 amplifier model is just over £5,500, with small separate patchboards for analogue and digital circuits.

#### 4) Hybrid computers under £30,000

A computer covering the whole of this price range is the LH-505, which is assembled and commissioned by Lan-Elec for Hitachi, of Japan. This is a 100V solid-state machine, with a good variety of optional units. The component accuracy is 0.01% and there are large, detachable patchboards for the analogue and logic sections. One analogue console can accomodate up to 62 amplifiers, with the usual mixture of non-linear units, and up to four

analogue consoles and two logic/control consoles may be combined to form a large computer (which may then be rather unwieldy with six patchboards). It is usual to supply a versatile three-channel oscilloscope and a three-phase timer with each LH-505. All the necessary socket connexions are available for inter-facing to a digital computer. The PDP 8/I (manufactured by Digital Equipment Corporation) is being recommended for this purpose.

The basic LH-505 10 amplifier computer costs £5,850, ranging up to £22000 for a full 62 amplifier machine with all the logic facilities. SERVO-potentiometers may be added for about £1,100 per set of 18 pots and servo-function generators are also available. The PDP 8/I, with 8,000 words of core store, and the full recommended two-way interface would cost some £18,400, including installation and checkout.

The Solartron Hybrid series includes the HS 7-2, which is a 48 amplifier machine with sophisticated control facilities, costing approximately £14,000 when fully equipped. The HS 7-3 is similarly styled in a desk console and costs £20,000 when equipped with 72 amplifiers. A total of some 40 Solartron Hybrid Seven systems have been ordered.

Redifon-Astrodata Ltd. combines the analogue computing experience of Rediffusion and the Californian company of Astrodata Inc. R.A.L. offer three sizes of computer, using a standard 100V solid-state amplifier, having a -3db bandwidth of 30kc/s as a Summer. All these computers employ a fairly small type of patchboard. The smallest in this range is the Ci-150 analogue computer, of which four have been sold in this country, with a desk-style console holding up to 75 amplifiers, and costing in the range from £10,000 to £20,000. R.A.L. have also sold four of their Ci-175 hybrid computers, which has digital logic, operating at 6V with a separate patchboard. A fully-equipped Ci-175 machine, with 83 amplifiers, is now about £25,000. This computer can have manual or servo-set potentiometers, which are very reasonably priced, and two complete computers can be slaved together, as in the installation at Manchester University.

The E.A.L. TR-48 is a widely used machine which incorporates many features of the TR-20 and costs up to £15,000 when fully equipped, although it is doubtful if a user would embark on a new installation now that the British-developed Hybrid 48 is available. The Logic and Mode Control unit, employing 3.6V integrated digital circuits, has its own patch panel above the 10V analogue section. The LMC can accommodate ten plug-in logic modules and five modules for control and interface purpose. Typical prices for the HY-48 are between £9,100 and £21,000. In the U.S.A. Electronic Associates now sell a 580 hybrid computer, which is really a reduced version of the model-680 (described in the next section). Since the 580 is almost comparable in price with the HY-48, although offering greater convenience for the user, it is not being advertised in this country.

## 5) Hybrid Computers over £30,000

Applied Dynamics Inc., of Ann Arbor, Michigan, has a good reputation in the field of large analogue computers. Their agents in this country, a subsidiary of a Dutch firm, is Van Rietschoten and Houwens (U.K.) Ltd., now concentrate their efforts on the AD-4 hybrid system, none of which has yet been sold in the U.K. This is a sophisticated system for up to 288, 100V, amplifiers and is obviously designed for maximum operator convenience. There are large separate patchboards for the analogue and logic sections, and, if necessary, the AD-4 may be operated as four independent computers. Another feature is a built-in analogue/digital interface. Prices range from £28,500 for the very basic AD-4A, with only 28 amplifiers, up to £157,000 for the full AD-4H, with 256 potentiometers, 64 multipliers and a very wide range of non-linear and logic modules.

The Solartron range is completed by three large machines known as the D series, because of the built digital computer (commonly a PDP 8/S) for control purposes, which also is used as an interface into a larger digital computer if required. The prices range up to about £100,000 for the 288 amplifier HS-12D, above which multiple installations are possible.

The largest computer from Redifon-Astrodata is the Ci-5000, with capacity for up to 350 amplifiers in the one console, and built-in digital interface. The price ranges from £40,000 to £120,000. This system can include servo-set diode function generators and High-speed digital attenuators for automatic coefficient setting. The Ci-5000 can be linked with almost any modern digital computer.

The amalgamation of Electronic Associates with the Control Data Corporation will lead to a company extremely powerful in the large hybrid computer business. E.A.L. at present offer two medium to large hybrid machines, the ten-volt 680 (known as the 690 when supplied with the model 640 digital computer) and the 100V model 8845 (which includes a complete digital computer and interface).

The 680 system has a capacity for 156 computing amplifiers (with a bandwidth to 500 kHz), 24 comparator amplifiers, 12 handset potentiometers and 120 servo potentiometers. The parallel logic system employs integrated digital circuits and each general-purpose logic gate is provided with an output indicator light. Prices for the 680/690 system range from £12,000 to £135,000.

Two of the large 8845 full hybrid computers have been sold to the British Aircraft Industry. This machine can have up to 260 amplifiers (100V and bandwidth of 200 kHz) 240 potentiometers (hand or servo set) 72 Multipliers and 100 general purpose logic gates. The digital computer section has a basic store of 4096 seventeen-bit words, high-speed paper tape reader and punch and a medium-speed line printer. The price of such a system can range up to

£250,000, which ensures that the educational market is rather limited.

6) Companies in the Analogue/Hybrid computer market

Computing Techniques Ltd.,  
Westminster Bank Chambers,  
Bridge Street,  
Leatherhead, Surrey.

Daystrom Ltd., (Heathkit),  
Bristol Road,  
Gloucester, Glos.

Electronic Associates Ltd., (PACE),  
Victoria Road,  
Burgess Hill, Sussex.

Lan-Electronics Ltd., (Lan-Elec),  
97 Farnham Road,  
Slough, Bucks.

Physical and Electronic Laboratories Ltd.,  
28 Athenaeum Road,  
Whetstone, London, N.20.

Redifon Astrodata Ltd.,  
Brookside Avenue,  
Littlehampton, Sussex.

R. and H. Applied Dynamics,  
Van Rietschoten and Houwens (U.K.) Ltd.,  
22 Park Street,  
Croydon, Surrey.

Solartron Electronic Group Ltd.,  
Analogue Computer Division,  
Farnborough, Hants.

System Computers Ltd.,  
Fossway,  
Newcastle-upon-Tyne,  
NE6 2YD.

Westinghouse Brake and Signal Co. Ltd.,  
Educational Aids Department,  
"Westalite House",  
Bradford Street,  
Birmingham.

A.M.Lock and Co. Ltd.,  
Prudential Buildings,  
Union Street,  
Oldham, Lancs.

## A CSE COMPUTER SYLLABUS

BY F.J.Stockwell,

General Adviser, London Borough of Havering

Readers may be aware of the enthusiastic and energetic pioneering work of W.R.Broderick in forming and developing the Computer Department of the Royal Liberty School, Romford, and of his efforts to expand the facilities thus offered to embrace more schools within the Borough of Havering. A major step forward was taken recently with the initiation of courses for Computer Studies leading to an optional paper (Mode III) in the appropriate Certificate for Secondary Education. Such a step is consistent both with Broderick's outward looking attitude towards Computer Education and with the Borough's encouragement of curriculum development in diverse fields (Science, Mathematics and French for example).

The fundamental reasons for taking such a step are closely linked with the underlying philosophy of computer education. Computers are going to become increasingly important in the everyday lives of all of us and this fact alone justifies them a place in the curriculum. The coming generations must realize the part computers are going to play in commerce, industry and science. Therefore, as many pupils as possible should make a study of the computer and of its essential programming. Such a study (particularly with those not destined to become professional scientists and mathematicians) helps to correct the impression that the human race is destined to be controlled by machines. There is no better way of assessing the limitations of machines than by using them and no better way of removing the innate fear of them, than by becoming familiar with them. For the professional scientist and mathematician, of course, the computer is going to be an essential tool. Vocationally, too, computer study is important: it is probable that all the training facilities now available are insufficient to meet the rapidly growing demand for computer personnel. But if there is one reason for computer education more significant than any other, it lies in the belief that computer study fosters logical thinking at an early age, illustrates mathematical concepts, ideas and operations, and stimulates interest in the nature of the functions which the machine performs.

The splendid advantage of arranging computer courses for pupils of Havering schools is that each and everyone of them may have the opportunity of direct access to the computer of the Royal Liberty School. The teachers and others who planned the new CSE computer course believe that such access is essential so that pupils can both gain experience by running their own programmes and by

observing their errors as soon after writing the programmes as possible. Experience has already demonstrated the **inadequacy** of a system employing a computer remote in distance and time: it is possible for a pupil to have a dozen programmes in the pipe line, so to say, all containing the same fundamental error before the first programme is returned to reveal the error.

A preliminary survey of the area taken early in 1967 revealed that some 15 schools out of the Borough's total of 30 secondary schools would be interested in a CSE Computer Course. A rough syllabus, which leaned heavily on that of Meredith from Merioneth was drafted out and copies sent to all the interested schools for comment. Although many of the staff concerned were not familiar with much that was in the syllabus, there were some who had already become proficient as programmers at courses organised for teachers at the Royal Liberty School. Suggestions which were fed back led to a modification of the syllabus to include Algol, approximations, work on errors and to exclude a number of items already included in the common core syllabus, for it soon became evident that the computer work would form one of the options taken in addition to a common core. It was realised at the same time that the majority of school staff concerned with the syllabus would need considerable special training.

Consequently, the Authority took the bold step of arranging a course based on the syllabus submitted to the East Anglian CSE Board for its teachers as part of its normal in service training. It was originally thought that some 10 days full-time instruction would be necessary because of the syllabus required not only a knowledge of programming and of computer applications, but also of familiarity with a number of topics which might broadly be classified as Modern Mathematics. Eventually a compromise was reached and the course was planned to last for five full days with the requirement that all attending it should do a four days Algol Course later in their summer holidays if they had not already done one.

The course was run at the Authority's temporary Maths. Centre housed in two hatted classrooms on a Primary School site. The Centre was adequate in most respects and the co-operation of the nearby Junior School provided the essential refreshments needed to counteract the near tropical weather which prevailed at that time. Much consideration was given to selecting the right time for the course. A holiday course makes it almost impossible to guarantee that all the staff who want to attend will be free at the same time. On the other hand an in term course throws added burdens on the schools whose staff wish to attend. The latter end of the summer term is the least likely time to cause hardship but the last week is a busy one because staff are collecting books and tidying round generally. Eventually, we settled on the penultimate week of the Summer term 1967 and 20 industrious students slaved for five long days in weather more appropriate to outdoor pursuits than to intellectual gymnastics.

Intelligent planning ahead arranged for a half-day trip to Southend halfway through the course. Southend is a mere 20 miles away, but despite the urgent need of relaxation we never saw the sea, but spent all the time visiting the computer installation of the Customs and Excise Department. The rest of the Course was tough going - but we never let up. Students were never permitted to relax and were required to work out exercises during frequent tutorials spread through the Course.

We recruited lecturers partly from our own teachers who were already accomplished in the computer field, partly from industry and commerce, and partly from specialists in the field of computer education.

On Monday we ploughed through digital and analogue number representation, use of binary codes, binary arithmetic, sets, subsets, union and intersection of sets simultaneous equations and inequalities, locus problems and simple circuits.

On Tuesday we coped with essential features of the electronic digital computer, stored programmes, use of flow charts, branching, loops, machine codes and machine independent languages.

On Wednesday, before the coach trip to the seaside, we broke the back of the common core syllabus, approximate methods for solving equations and elementary ideas on errors.

On Thursday the pace began to slow and we heard about simulation and Monte Carlo methods, the control of industrial and other processes and management and design techniques. We thought this day was very important for although we take the view that to be of value a course in computing should be practical, so that course work earns a large proportion of marks in the examination, we also consider a knowledge of the applications and limitations of the computer to be very desirable.

On Friday we turned our attention to switching techniques and staggered to a halt with a programme of films in the afternoon.

The consequence of this marathon effort is that 15 schools are this term beginning courses which will lead to their pupils sitting the new computing paper in Summer 1969.

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REPORT FOR THE BRITISH COMPUTER SOCIETY WORKING

PARTY NO. 4

THE AVAILABILITY OF HARDWARE SUITABLE FOR SCHOOLS

This report is intended to give an outline of the equipment available to schools and which is suitable for the various branches of computer education. It is divided into sections as follows:

1. An examination of the availability of material suitable for the construction of simple computer logic circuits which could lead to complete working model computers.
2. Ready built logic trainers and trainer computers.
3. Small programmable calculators which will perform a sequence of operations.
4. The small computer generally in the price range of £4,000 - £10,000.
5. The small-medium computer generally in the price range of £10,000 - £20,000.
6. Second-hand computers.
7. Data Links.

1. Availability of Material suitable for construction of Logic Circuits

The supply of this type of material is both plentiful and cheap and the construction of circuits does afford an easy way of introducing computer education into schools. A good supply of literature is available from manufacturers and from booksellers giving elementary logic circuits for computer model construction.

The usual electrical components such as resistors, capacitors, wire etc., are available through dealers advertising regularly in monthly radio or electronic magazines as also are cheap transistors. It is recommended however, that cheap components should be used until confidence, using high quality material, is acquired. A list of Manufacturers or Dealers supplying high-quality material suitable for such projects is given below. These people handle such things as transistors, integrated circuits, power supplies and the usual electrical or electronic components.

Transistors vary considerably in their characteristics and price but the silicon switching transistor is required in a large number of logic circuits and

improved production techniques have lowered the price considerably.

Integrated circuits, where a number of logic elements are contained in a case which would previously have housed a single transistor, has taken a lot of the uncertainty out of the construction of the more critical circuits. Students can now construct a more complex set-up with relative ease.

Power supplies required for transistor circuits need to be stabilised. It is possible to purchase a complete stabilised power supply but these are costly and range from about £18 to £60 for the types likely to be used in schools. The cost is a function of the current output and ranges from about 0.5 to 5.0 amps for the prices quoted above. Fortunately logic circuits need small currents and the large unit would supply a very large network. Often a non-stabilised supply is already available in a school and a stabiliser can be attached to such a unit. Such a unit fits between the power supply and the logic circuit and needs an input voltage some 4 volts higher than the stabilised output voltage expected of it. This method appears to be a very satisfactory method from every point of view, including cost. Prices are in the range £10 to £25 for output currents of 0.5 to 5.0 amps.

The following list includes some manufacturers who will not supply direct but will supply the name of a distributor in the customer's area:

Mullard Ltd., Mullard House, Torrington Place, London, W.C.1.

A very wide range of semiconductor devices and integrated circuits as well as detailed characteristics and circuits suitable for school use.

Texas Instruments Ltd., Manton Lane, Bedford.

A very wide range of semiconductor devices and integrated circuits with detailed characteristics.

Newmarket Transistors Ltd., Exning Road, Newmarket, Suffolk.

As well as a wide range of transistors and integrated circuits Newmarket also produce packaged power supplies mainly for the radio market. While these are not fully stabilised they have been found to be useful in some logic circuit work and have the advantage of being small and cheap.

Welwyn Electric Ltd., Bedlington, Northumberland.

Celdis Ltd., 43/43 Milford Road, Reading, Berks.

Electrosil Ltd., Lakeside Estate, Colnbrook By-Pass, Slough

These manufacturers supply a very good range of integrated circuits.

A.Farnell Ltd., Kirkstall Road, Leeds, 3.

Distributors for a large number of leading manufacturers of electrical and electronic equipment. They will supply transistors, integrated circuits, logikits and power supplies.

Lan-Electronics Ltd., 97 Farnham Road, Slough, Bucks.

Power units specifically designed for their own range of logic tutors and so very satisfactory for direct connection to transistor logic circuits.

Grenson Electronics Ltd., Station Avenue, Tile Hill, Coventry.

Manufacturers of a wide range of stabilisers at prices which discourage self-building.

## 2. Ready-Built Logic Tutors and Trainer Computers

A number of manufacturers are now in this field and will supply comprehensive details of their products on request. An outline is given here of the products which they supply and which are likely to satisfy the appetite of the "Modern Maths" school and the teachers of Logic of the Electrical or "Combinational" type. In some cases the logic elements are fixed and are connected by leads which may therefore stretch some distance, while others are plug-in types so that the elements can follow, fairly closely, any logic diagram made by the student. Another type features a detachable plug-board which can be used remote from the tutor itself and has the advantage that a number of students can work with one machine by using plug-boards which are a low-cost part of the equipment.

These various approaches to the job to be done have their appeal to different teachers. It is hoped that the outline given below will help to form a picture of the range available.

Brensal Electronics Ltd. Charles Street, Bristol 1.

Logic Simulator                    £194

Mounted in a wooden cabinet with overall dimensions  $26\frac{1}{2} \times 19 \times 7\frac{1}{2}$  (inches) and supplied with a handbook and twelve laboratory sheets for experiments in logic design, this simulator is designed as a teaching aid for boolean algebra, binary code and logic functions. The instrument operates from 200-250 volts A.C. supply. All modules are self-illuminating so that the state of each circuit is shown at all times. The modules are fixed and include 24 NOR modules and 4 Binary Counters all with adequate input and output facilities.

Lan-Electronics Ltd. 97 Farnham Road, Slough, Bucks.

Lan-Dec LD-15 Logic Tutor	£55
Relay Unit RCU-5 for use with above	£18.10s
Power Unit (Will drive three of above units)	£22.10s

Lan-Dec 20M Integrated Circuit Logic Tutor	£99
Lan-Dec 300 Integrated Circuit Digital System	
	Simulator £310
Lan-Dec 310 Computer Arithmetic Tutor	£395

Lan-Electronics provide a range of logic tutors, computer trainers and power units and have had a lot of experience in this field, their Ld-15 was the first tutor to be produced in this country.

The LD-15 is a robust electronic logic tutor 19" x 10½" x 3½" and supplied by a power unit, not included in the price stated, or by a set of dry batteries. It has a set of 15 fixed transistor resistor logic gates, 5 push buttons, 5 read-out lamps and a telephone dial. Two hand books are available for school and college use. Additional units can be added to the first unit and a frame is available for mounting together two LD-15 and one RCU-5. The relay unit is designed to control external systems or experiments.

The LD-20M is a fully integrated version of the LD-15 having 14 gates, 5 J-K flip-flops, 6 indicator lamps, a buffered telephone dial and built in power unit.

The Lan-Dec 300 is an integrated circuit digital system simulator designed for more advanced level training and industrial system simulation and employs 8 plug-in 32 way printed circuit cards. A range of these cards, designed for special functions, is available from the supplier but blank cards can be supplied for student projects. The cards plug into the top of the cabinet and connect to the coded sockets on the front of the unit. Switches, push buttons and a telephone dial provide alternative input conditions and an additional panel is fitted with lamp indicators and buffer amplifiers. The dimensions are 20" x 20" x 17" and a stabilised power unit is incorporated so that the whole unit is supplied from the normal A.C. mains.

Designed as a visual aid for digital computer arithmetic, the Lan-Dec 310 is a compact tutor with three ten-bit registers, a serial adder, a complement unit, an AND gate and delay unit. A telephone dial will generate shift pulses but a complete cycle (at 1kc/s) can be produced by an inbuilt clock. Demonstration of the four basic arithmetical operations is possible but division is by repeated subtraction the operation being terminated when the remainder becomes less than the divisor. The dimensions are 20" x 20" x 17" and this unit incorporates integrated circuit cards compatible with the LD-300 design aid.

Lan-Electronics also supply trolleys which are designed mainly for their range of analogue computers but it is worth noting that these are available as they can be very useful where space is at a premium. Trolleys are available from £19.

Feedback Ltd., Crowborough, Sussex.

Logikit Primer and Mounting Deck LK 255	£155
Logikit and Mounting Deck LK 250	£340
Digital Computer Trainer DCT 350	£475
ABACUS Arithmetic Unit EC 360	£1125
ABACUS Educational Computer EC 360/370	£1825

Listed above is a range of educational aids which cover a very wide range. The first two, the LK 255 and LK 250 are respectively a small plug-in logic kit and a larger version capable of handling larger demonstrations particularly in combinational logic. These are models which can follow the logic diagram made by the student. The DCT 350 is a demonstration unit which can be used to show serial binary operations. The 360 is a serial mode, fixed-point, 16 bit binary arithmetic unit, while the EC 370 forms, with the EC 360, a fully programmable, single address, 16 bit, serial digital computer capable of low or high speed operation. Brief specifications of these models are as follows:-

LK 255 For introductory experiments. 15 plug-in logibits with mounting board containing manual input switches, manual sequence switch, and 6 buffer indicator lamps. Dimensions: 20" x 11" x 5".

LK 250 A bigger unit with 60 plug-in logibits which include a clock and 9 bistables. The mounting deck is larger with positions for 32 logibits. Additional mounting decks can be linked to this deck. Both this unit and the LK 255 can be supplied from 100/125 or 200/250 volt A.C. supply. Dimensions: 22" x 16" x 9".

DCT 350 This model will shift, add, accumulate, complement, subtract, multiply by successive addition or by shift and add and divide by successive subtraction. There are three registers and step by step operation is possible or a telephone dial can produce a predetermined train of pulses. A built-in clock can be used for high speed operations. A comprehensive manual is supplied with the unit. The unit is supplied from the 100/120 v A.C. or the 200/250 v A.C. supply. Dimensions: 20½" x 12" x 16½".

EC 360/370 The Arithmetic unit (360) can deal with positive integers in the range  $0$  to  $2^{16} - 1$  or signed fractions in the 2's complement notation in the range  $-1$  to  $1 - 2^{-15}$  and will handle all four basic arithmetical operations. The EC 370 is the control unit and incorporates a ferrite core store and may be operated independently to demonstrate programme interrogation and control cycle by means of hand key controls. The system can be extended to accept peripheral equipment for demonstration of computer power and for actual computation. Both units need 240 v A.C. supply and have dimensions of 28½" x 19" x 47" with a console projection of 8".

System Computers Ltd., Fossway, Newcastle-upon-Tyne 6.

Logic Tutor £385

The Logic Tutor has been designed as a teaching aid to the understanding of combinational logic and digital computers. Inexpensive, removable, 336 way, patch-panels enable one tutor to serve many students, facilitates supervision and allows patched circuits to be stored for future demonstrations. The unit is supplied complete with patch board and connecting leads as well as a comprehensive manual.

The unit contains thirty positive NAND gates, four counting elements and two driver outputs as well as a group of input switches and a number of external component terminals and output lamps. The unit is constructed from Elliott Minilog Elements. The unit is contained in a cabinet 20" x 10" x 7" and needs a 230 v A.C. supply.

Westinghouse Brake and Signal Co. Ltd., 82 York Way,  
King's Cross, London, N.1.

Arkay Computer Trainer Model CT 650

£306

This trainer is a complete, easily programmed, manually operated computer. It contains the following basic units : Encoder and Decoder which allow conversions from dec. to binary and binary to decimal. An arithmetic unit performs addition and subtraction on binary numbers and there is a control unit, a drum store and a simulated core memory.

The model has a 4-bit data word, a 10 instruction repertoire, a 100 word drum memory and a 5 word store. It allows for the programming of such operations as multiplication, division and square root.

### 3. Small Programmable Calculators

There are now many machines on the market which the manufacturers call computers but which are in reality large calculators. The criterion adopted here is whether the machine can be programmed or not.

#### Notes on individual machines

##### 3.1. MATHATRON

£1880 to £4310 less 5% and duty

Available from Scientific and Computing Instruments Ltd.,  
Boundary House,  
Boston Road,  
London, W.7. Tel: 01 - 579 - 0773

Essentially, this is a grown-up calculator. Input is by pressing the appropriate keys, output is the decimal numbers printed on a roll of paper tape. There are a variety of useful hardware routines which must be specified when ordering. The cheapest model (no. 424) has four registers and up to 24 steps of program. The next model (848) is twice this size. There are optional program storage units giving up to 48 registers and 480 program

steps. An ASR-33 Teletype can also be added giving paper-tape input and output and also alpha printing facilities.

3.2. OLIVETTI Programma 101 £1885.10s

Available from British Olivetti Ltd.,  
278-282 High Holborn,  
London, W.C.1.

Tel: 01 - 242 - 1141

This is a desk-top calculator that also has a limited memory. It uses a system of magnetic cards for program input. Input of data (or of program when put onto a card) is by pressing the appropriate keys, output is numeric only printed serially on a fairly wide paper tape. A very wide range of software routines is available as sets of magnetic cards. There is only one model and it cannot be added to from the hardware point of view. It has been extensively tried in schools (primary and secondary) and withstands all usual treatment. The cost price includes one year's free service, a selection of software packages and a training course for a teacher. Maintenance costs £90 p.a. (fixed charge) with a half-day service in almost all parts of the country.

3.3. WANG 300 SERIES

Available from Wang Laboratories Inc.,  
27 The Stewarts,  
Bishop Stortford,  
Herts.

Tel: 0279 - 51174

This is a wide range of electronic calculators in which the keyboards are separated from the electronics packages. Several keyboards can be operated simultaneously under certain conditions from one electronic unit of appropriate type. Input is by pressing keys, output is by electronic numeral display panels. Different functions from +, -,  $\bar{1}$ , x, + up to  $\sqrt{x}$ ,  $\log x$ ,  $e^x$  and sin, cos,  $\sin^{-1}$ ,  $\cos^{-1}$ . Programs can be punched and read on a special card programmer unit, and an ASR-33 Teletype can also be connected.

4.1. BIT 480 SERIES

Available from Compugraphics International Ltd.,  
The Croft,  
Croft Road,  
Aldershot,  
Hants.

Tel: Aldershot 21386

This is a general purpose digital computer made by Business Information Technology Inc. in the U.S.A. There is a possibility that this machine may be made, or assembled, in the U.K. which will reduce the prices; there is also no clear policy yet over any educational discount.

A wide range of units can be purchased, and the machine can therefore grow in size as demand dictates. The simplest arrangement would be the central processor, an

ASR-33 Teletype for input and output, and 1k of 3 $\mu$ s core store - this would cost about £4100 at present. Hardware for decimal arithmetic would probably also be required at about another £130. The core store can extremely easily be increased to 2, 4, 8 or 16 k bytes. There is a Fortran compiler available which needs a minimum of 4k storage. Algol is not yet available. At these prices, the machine would come ready for rack mounting, or it could very easily be mounted on a trolley for movement into different rooms.

#### 4.2. PDP/8S

Available from Digital Equipment Corporation (U.K.) Ltd.,  
 Arkwright Road,  
 Reading,  
 Berks. Tel: 0734 - 85131

This is the smallest of the large range of Digital PDP digital computers. The standard unit would include the central processor, 4k store and ASR-33 Teletype for input and output. Optional Power Failure Protect and Auto-Restart can be specified on ordering. The core store can be extended to 32 k words, or a disc file system can be added later for £2900 plus cabinetry. Fortran and Algol compilers are available for use with the 4k store.

#### SUMMARY OF FACTS

	PDP/8S	Mathatron	Olivetti	Wang	BIT
Registers of size core store	4k up	$\leq 42$	10	2 $\rightarrow$ 64	1k-64k
Maximum no. program steps	$\infty$	$\leq 480$	150 per card	$\infty$ (A)	$\infty$
Hardware for nesting	-	✓	✓	✓	-
Hardware for powers, sq.rts	-	✓	✓	✓	-
Ability to take branching programs	✓	?	✓	?	✓
Ability to take conditional jumps	✓	?	✓	?	✓
Trig. functions (hardware)	(software)	A	x	A	subrou-tine(A)
Ability to take Fortran, Algol, etc	✓	x	x	x	✓
Paper tape read/punch (i.e. printing of pages, alpha work etc)	✓	A	x	A	✓
Cost	£4800	£1880 to £4310 less 5% & duty	£1885.10	£785 - £3205 without duty	£4100 to £5600 approx

(Note: A - this means that the facility is available on some models if specified on ordering).

## 5. Small-Medium Computer

The PDP8 is produced by the Digital Equipment Corporation (Programmed Data Processor). It is marketed as a small scale general purpose computer. It is a one-address, fixed word length, parallel computer using 12 bit, two's complement arithmetic.

The cycle time of the 4096-word magnetic core store is 1.5 micro seconds. Addition with accumulator loaded is 3.0 micro seconds and subtraction is 6.0 micro seconds. Multiplication and division which are performed by subroutines take 315 and 444 micro seconds respectively. A hardware extension can reduce this to 15 and 30 micro seconds.

The standard system provides facilities for indirect addressing, instruction skipping and program interrupts. The system is delivered complete with a standard teletype ASR33 which operates at 10 characters per second. This device allows information to be supplied via the keyboard or the paper tape reader and likewise output on the page printer of the teletype or on the paper tape punch.

The interface circuits allow a great variety of peripheral equipment to be connected. A wide range of devices is offered by Digital themselves.

The PDP8 is a self contained system which requires no special environmental conditions. The power supply required is a 115 volt 60 cycle (7.5 amps) supply (.78Kw). Reliable operation requires ambient temperatures between 32 and 130 degrees Fahrenheit. The standard software includes an Assembly code compiler for a system called PAL and a FORTRAN system. This latter system is of most interest to schools. The stated restrictions on the Fortran compiler (e.g. only single-dimension subscripts) do considerably reduce the power of FORTRAN although the system does provide an easy-to-learn programming language.

The physical size of a basic system is a CPU in a cabinet

$69\frac{1}{8}$  x  $22\frac{1}{4}$  x  $27\frac{1}{16}$  inches

with fitted table (removable) of

$27\frac{1}{16}$  x  $31\frac{1}{4}$  x 18 inches

Then there is a free standing teletype ASR33 which is attached by cables to the cabinet.

## 6. Second-Hand Computers

From time to time second-hand computers become available from a number of sources which obviously cannot be listed. Some schools have successfully installed second-hand computers but there are dangers involved in this kind of purchase and it would be well to point these out. The main danger lies in buying, or receiving as a gift, a first generation computer. Such a machine uses valves rather than transistors and has the following disadvantages over modern equipment:

- (i) It is very heavy and bulky.
- (ii) Electricity requirements are high and a very robust power supply is needed.
- (iii) Maintenance costs are high.
- (iv) It can be very unreliable.

The enthusiasts in the schools which have already accepted this type of equipment have learnt a great deal but there seems no prospect that such equipment can provide a permanent educational service. Very often, because these schools have been first in the field, they have received aid which could not be repeated to a large number of schools.

Second-hand, second generation, computers are a different matter entirely. Although the initial cost is likely to be higher it is possible to acquire a computer network with years of useful service at a price which is less than comparable new equipment. Machines which originated in the late fifties are likely to be slower than their modern counterpart but there is little drawback in this from the schools' point of view. A second-hand Elliott 803 with an 8K store, floating point unit, tape reader and punch, i.e. the minimum configuration which would enable Algol programs to be run, might be purchased for about £12,000 to £13000. Such a machine could satisfy the needs of about 15 schools. Installation costs might be high as double glazing and air conditioning would be required and the cost of maintenance, which depends on a number of variables, would not be cheap.

## 7. DATA LINKS

A school which is able to persuade a Technical College or University to provide computer power is faced with one of four alternatives:

- a) Programmes can be written by hand in the school, sent to the computer centre to be punched and run so that errors (or answers) can be returned to the school.
- b) The school can acquire its own tape or card preparation equipment so that punched tape or cards travel backwards and forwards between the school and computer.

c) Off-line data links via the G.P.O. telephone or Telex network can be established so that punched tape prepared in the school, or produced by the computer, can be used to generate an identical tape at the other end.

d) On-line links can be made so that an outstation in the school is connected directly to the computer. A student using this configuration would type in the school and receive an immediate response from the computer; he would be able to edit, file and monitor his program by means of a command language incorporated into the system.

These four alternatives are arranged in reverse order of convenience to the user, but are in order of cost. All four methods are being used by schools at the present time.

Another method of providing power for a school is to bring the students and computer together at certain scheduled times. There are two ways of doing this:

a) By organising visits to a computer centre on an open-shop basis where students can prepare and run their programmes in one session.

b) By visits from a mobile computer to the school for (say) half a day a week when the students will use the computer on an open-shop basis.

The difficulties here are in timetabling and distances as well as the further disadvantage that if work is incomplete at the end of a session it must wait some time before it can be finished.

Should a system be required then it would be well to call on the experience of the pioneers in this field in this country. An extensive school teleprinter network is being created in the two boroughs of Enfield and Haringey where schools are being linked to Enfield College.

At Towyn School an experiment is being run in which a link is being used between the school and an Elliott 803 at University College of North Wales, Bangor.

Hatfield School has a link with the College on the same campus.

## The First Twelve Months of Operation

(A report on computer education at the South Shields Grammar Technical School for Boys)

by: Mr.C.Dixon

Quite a lot has been written recently of the various ways in which different schools have tackled the problem of the introduction of computer programming. Most of the work described is necessarily of a theoretical nature because of the inaccessibility of a computer. We all know of the success of the Royal Liberty School following the acquisition of a new machine and a few other schools are now in the happy position of having links to nearby computers. But progress in this field is seriously slow and one cannot see any significant long term improvements.

Under these depressing circumstances one may wonder why the use of second hand machines, although tentatively advocated at first, has not caught on. On the contrary the so-called experts condemn out of hand the adoption of such machines - I refer to the recent one-day Conference on Computers in Schools, held within the 1967 Datafair Conference at Southampton when the question of second-hand machines was allotted no more than one minute's consideration. It is interesting to note however in Prof. Bryan Thwaites recent report on his visit to Russia, he relates how valve machines are in common usage in schools.

As we have now had a Ferranti Pegasus Computer (formally owned by London & Manchester Assurance Co.) for one year I thought it necessary to relate our experiences so that interested members may judge for themselves the pros and cons of such a venture.

The original discussions between Headmaster and members of staff took place in 1965. The main difficulties as we then saw them were as follows:

- 1) maintenance of computer
- 2) cost of installation and maintenance
- 3) where the machine was to be installed
- 4) in service training for members of staff in the teaching of computer programming.

The success or failure of such an installation depends on very careful planning and many months passed while details were checked with consultants and visits made to the computer which was still operative in London. (Should anyone be interested in such details they are readily available, by letter).

The computer arrived in September 1966 but because of the discouraging difficulties of co-ordinating local labour, electrical contractors, building alterations etc., all of which were outside our control, the computer was not re-commissioned until February 1967.

In the mean-time, however, a part-time member of staff, a previous programmer in Industry and a graduate in Mathematics, had been employed, and as from September 1966 both staff and pupils were learning the ins and outs of computer programming.

Furthermore a new laboratory technician, (an electrician) was employed, whose job would ultimately be to maintain the computer. The recommissioning of the machine was in the hands of a local computer engineer who was already in control of two similar machines in industry (International Research and Development, Newcastle-upon-Tyne). This seems quite a significant point that one must be relatively near a qualified engineer who can help out in times of emergency. A man of this calibre should not be too difficult to find in industrial regions and one must never underestimate the help which industry is prepared to give to schools and other educational establishments.

Since February 1967 we have had only one major breakdown due to the failure of a rectifier - one of the few items for which we do not have spares. We do have a second Pegasus machine, donated by Shell. The machine was out of operation for about two weeks. Apart from this we have had the odd two or three day periods of inoperation but these are becoming less prevalent as our own technician becomes more experienced. Again I think it is significant to quote the computer engineer when he assures us that we have a very reliable machine.

But what of our progress as far as the boys are concerned? At the moment the teaching of computer programming is governed by the availability of our part-time programmer and two other members of staff. Again, contrary to wide-spread opinion, we begin teaching the Pegasus Autocode as far down the school as the 2nd form. Furthermore the pupils do their own punching of tapes and operate the computer under supervision. The preparation of tapes is time consuming and we must find some way out of this difficulty in the future.

Interest is considerable at first but eventually can wane with the boy of poorer ability just as anything else with which he is confronted. We have found that about the top twelve boys in a form of say thirty as far as mathematical ability is concerned are also the best at computer programming though not necessarily in the same order.

In the VIth form we have been amazed at the capabilities of certain boys. A nucleus of about six boys show outstanding ability and spend much of their own time in genuine research as far as they are concerned. Within twelve months they have mastered many different codes in order to alleviate difficulties which they have encountered.

A few of their activities are listed below:

Suppression of positive signs in autocode  
Drawing of simple graph by computer

Investigation of Fermat numbers  
Investigation of Prime numbers  
When does a series begin to converge?  
Necessity for second tape reader  
Text instructions  
A War on Want Analysis for the Borough  
Compilation of School records  
Use of handswitches  
Post-mortem facilities on a program which has failed  
Multiplication of matrices  
Adjoint of a matrix  
Eigen values  
Playing of games such as hexapawn, nought and crosses.

Although modern mathematics is taught in the school we are not yet committed to any such examination and so find it difficult to examine computer work. However there is such opportunity in our Mode iii C.S.E. examination. Incidentally I have found quite a few University Mathematics Departments interested in our work and welcome applications from students well-versed in computer programming.

In connection with teacher training we have run a one-week course for secondary school teachers in the Borough; subsequent to this course, two other schools now avail themselves of the computer services available at our school.

As detailed a record as possible was kept of the installation of the computer by the making of a sound film - this could possibly be made available on request.

You will have gathered by now that we ourselves have found our pioneering a success and although we would obviously not claim that this is the answer to all problems in computer education at least we claim to be doing something positive and we are thankful to our Local Authority for their far-sightedness in making possible such a venture. At least in a few years time we should have a concrete case, based on experience, for the installation of a modern machine.

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LETTERS TO THE EDITOR

P.Giles,  
43 Polmaise Road,  
Stirling.

15th April 1968

Dear Sir,

The Bulletin gives a clear picture of the progress being made in Computer Education but from a user's point of view the bias towards the earlier applications of computers based on extensive mathematics and numerical analysis seems a pity. Nowadays computers are being used more and more for the storage of information and to control transmission of information. This field is non-mathematical in the traditional sense, but the following practical problems are not far from modern mathematics at a fairly elementary level.

1. Information storage.
  - a) The hierarchical or level structure of a dictionary or filing cabinet - exemplified in COBOL data division.
  - b) The labels required to ease access to files, to prevent their accidental destruction, and to limit access to authorised sources.
  - c) Rearrangement of files by sorting, efficient methods, use of indexes, character sets and elementary syntax.
2. Information transmission.
  - a) Exchange of files in standard format.
  - b) Telegraphy and the discovery and correction of errors by redundancy, by parity, or by check digit.

Yours sincerely,

Philip Giles

361 Tudor Road,  
Leicester.

20th April 1968

Dear Sir,

I enclose a contribution to your letters column which I hope will be of some help to the less fortunate schools interested in the field of computers. With teleprinters available at £15 a time and auto transmitters available

at between £8 to £14 it is not out of the range of the poorest school.

I wonder if you would be interested in an article based on the work we are doing in Linwood. I recently gave a paper at the Annual Conference of the Association for Programmed Learning on our project. The title was "The Linwood Experiment - Programmed Learning in remedial education - an experiment in computer-assisted feed-back technique".

We have a 20 station feedback classroom and we use our computer facilities (2 K.D.F.9, 2 Elliott 803, and an I.C.T. 1905) all of which have Algol compilers, for analysis of response information.

We do a little teaching of Algol to the 3rd year but so much time spent with the feed-back classroom that we have not the time to develop computer programming as a school activity on the time-table. (We hope that this will change next year when the maths. Dept. will witness a re-shuffle, the present difficulty is that I am not in the maths. Dept. but am head of the remedial dept. and unfortunately there is no-one else on the staff that can write Algol, whilst I shall remain in the remedial Dept. the new maths. master will probably induct programming to the classroom).

Yours faithfully,

Elwyn Rees.

#### BITS AND BYTES

Proposed Association of Computer Units in designated Polytechnics and other colleges.

A meeting was held on March 29th, at Hatfield College, during which it was agreed to form an association for computer units in the proposed polytechnics and other colleges having a major interest in the computer education field. The first chairman of the committee will be Dr.R.W.Sharp of Hatfield College and the secretary is Mr.J.S.Hillmore of Northern Polytechnic.

A second meeting was held at Rugby College of Engineering & Technology on June 27th to consider the detailed constitution and aims of the association. We hope to include regular news of the activities and progress of this association in this bulletin.

#### London Branch of C.E.G.

This branch was formed officially at a meeting in the County Hall Westminster, on May 29th. The secretary will

be Mr. L.R.Crawley of South West London College. The meeting was addressed by Professor S. Gill (Imperial College), Mr. C.W.Blaxter (N.C.C.) and Mr. J. Southall (B.C.S.). The membership fee for this branch will be 5/-, in addition to the 10/- for membership of the C.E.G.

#### Regional Computing in Eastern England

A one-day symposium on "Computers in Further Education" was held at Cambridge on June 13th, sponsored by Honeywell E.D.P. Amongst other papers there was a strong plea for a start to be made with plans for a regional network for computer education. This proposal was promised support by H.M.I. Mr. Bird and provoked a good deal of discussion.

#### Computer Science Syllabus

We have received a copy of the Computer Science syllabus for G.C.E. from the Associated Examining Board. There are also some sample examination questions. Copies may be obtained from the Editor.

#### Multi-access on Elliott 803

A detailed report has now been issued on the limited multi-access facilities for the Elliott 803 computer at Hatfield College. This report describes the single-user BBC 1 language and the proposed BBC-2 language, for three simultaneous users. The full order code is listed in the text, copies of which may be obtained from the Director of the Computer Unit, Hatfield College of Technology.

#### Structural Analysis Programs

I.C.T. have announced that a suite of programs are now available for structural analysis work, in the design of bridges, buildings and vehicles, on the 1900 series of computers. These programs are largely based on successful Atlas programs used for design analysis of the Gyrotron at Expo 67 in Montreal.

#### Basic Language Computer

The Ministry of Technology has agreed to support research by I.C.T. into the so-called Basic Language Computer. This is an attempt to re-think the internal organization of a computer and its associated language now that the engineering restraints of the hardware are less significant.

#### Business Management Exercise

All I.C.T. 1900 users can now make use of the programs and supporting documentation for a business management exercise. This is intended as an educational aid for management students with little or no experience and requires three teams, each of about four people.

Minutes of the Annual General Meeting of the Computer Education Group held at Leicester College of Technology on Friday 3rd May at 2.00 p.m.

19 members were present and apologies were received from another 8 members.

Minutes The minutes of the 1967 Annual General Meeting were approved (the names of officer's to be inserted). It was agreed to publish a list of members with the minutes of this 1968 Annual General Meeting. This list is now available on request from the Editor (Computing Centre, Enfield College).

Secretary's Report. The bulletin is now becoming the exchange of information it was envisaged. A teachers course had been arranged at Enfield during the first two weeks of July. Branches of the Group are now being formed in various parts of the Country.

Editor's Report. 800 copies of the latest bulletin were printed by Enfield College Computing Centre.

Treasurer's Report. Membership increased during the last year to 312 ordinary and 73 institutional members. Unfortunately about 100 members forgot to renew their subscriptions after the last Annual General Meeting. Upto now we have continued to send them copies of the bulletin. Thanks to Enfield College we do not have to pay for production of the bulletin. This has greatly eased our financial situation. From the total cash in hand will be deducted the B.C.S. loan of £100 and £18 for literature sold on their behalf. This will now be returned to B.C.S.

Branch Reports. Lancashire - Chairman - Mr. Peacock several meetings have been held with an average of 18 people present.  
Leicester - Chairman - Mr. Lovis. This branch has had one formal and one informal meeting the next will be held in June at Loughborough.

Middlesborough - no report available.

Lancaster - no report available.

London - no report available.

Election of Officer's

Chairman - Dr. H.L.W. Jackson  
2 Vice Chairman - Mr. F. Lovis and Miss D. Law  
Secretary - Mr. D.E. Conway  
Treasurer - Mrs P. Jackson  
Joint Editors - Mr. N. Bowker, Mr. D.E. Conway  
Ordinary Members - R. Chamberlain, W. Broderick,  
S. Friis, D.G. Smith,  
D. Stubbings, R.L. Thompson.

Branch Chairmen or their representatives are members of the committee.

Mr. W. Broderick was elected to the Committee to replace Miss Law.

Auditor - Mr. D.E. Rabbit

It was decided to send Miss Law flowers from the group.

Local Branch Secretary's are going to look into the possibility of sales of the bulletin in bookshops. It was proposed that each branch secretary should become an institutional member and receive 4 copies of the bulletin.

It was left to the Committee to decide the venue for the next Annual General Meeting. It was suggested that a meeting held at 5.30 p.m. would probably have a better reception.

Meeting closed at 4.00 p.m.

Mr. Abrahams and Mr. N. Bowker gave a very informative and interesting description of Computing at Enfield College.