COMPUTER EDUCATION

THE BULLETIN

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The Computer Education Group

of

The British Computer Society

"COMPUTER EDUCATION", January 1968.

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Computer Education Group 1967/68.

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Membership of the Computer Education Group involves a subscription of 10/- per year to cover the cost of producing this bulletin and circulating information. It also involves the willingness to help other members by pooling your experience in the computer education field.

Subscriptions should be made out to "The Computer Education Group (B.C.S)" and sent to Mr. D.E.Conway, at the address as above.

There is also an institutional membership for an annual subscription of £1, which entitles the school of college to four copies of the bulletin (and other literature) and to two votes at tha A.G.M.

Editor's Notes

In this issue we are pleased to welcome an article from overseas, which has been a rare event in the history of "Computer Education". At the same time as Professor J.Walsh was giving his lecture in England the editor was visiting schools and colleges in Ontario to discuss the present state of the computer education field.

It is interesting to compare the British and Canadian developments and to hear the various forecasts for the future. In Canada, outside a few of the universities, the total emphasis has been on the computer as a tool. We could find practically no interest in schools or colleges for logic circuitry or in analogue computers. This is in direct contrast to the interest in a number of British schools. The trend in Canada has been to use the computer first of all for administrative purposes, typically at the school board office, and it is only within the last year that much computer programming has been introduced at the high school level. As might be expected, with almost complete reliance on I.B.M. machines, the instructional language is always Fortran. In fact the usual problem in a British college of technology, that of choosing which make of computer to purchase, is non-existent in Ontario. The question is merely, "shall we have an 1130 or a 360/20?"

Having come by different routes, largely dictated by financial conditions, we would say that at this time almost an equal percentage of British and Canadian schools are interested in computer education, with a slightly more balanced approach in Britain. At the technical college level the Canadians have rightly put the emphasis in the business data processing field, while the British colleges have tended to emphasize the technical and scientific aspects.

A look into the future, over the next five years, presents a comparison which is much more disturbing for this country. In Ontario, at least, there is a plan for rapid development of computer education in schools and colleges, with a good prospect of the appropriate equipment and every encouragement for the teaching staff to aquire the necessary experience. In this country, on the other hand, development in the schools depends on the initiative of a few enthusiastic teachers. At the technical colleges the prospects for the acquisition of the right equipment are becoming less bright as time goes on. This was brought out clearly by the authors in the June 1967 issue of the Computer Bulletin (reviewed in this journal).

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Computing in Schools

Seminars addressed by Professor John Walsh of the Althouse College of Education, University of Western Ontario. (Sponsored by IBM United Kingdom Ltd.)

Preamble.

We are fast approaching the time when computers will form an integral part of the everyday life of everyone of us. There could be, soon, a moneyless society in which a purchase in a shop would be paid for by a deduction from the buyer's bank account and a similar incrementing of the shop's account. There is, at the moment, a change taking place in the Canadian telephone system whereby "touch-tone" phones are being introduced - the intention is to give readier access to computers through the public telephone network. In fact it is possible to visualize a time when schools would be abolished - pupils learning instead through television and computer systems linked to their own homes.

Computers have assisted doctors to diagnose - and hence prevent - illnesses. It has been forecast that life will be extended to 150 years. When should we pay a man his pension? At 70, in the prime of life? Or when he is growing old at 120? IBM 1130 computers are setting type for newspapers in London, Ontario and Toronto and making the services of many men unnecessary. Computers are even being used to diagnose car faults.

I mention these instances to show that computers will affect the lives of us all, in our ordinary activities. This is why we must introduce computers at a lower than University level so that we will catch the whole population. If we restrict it to University level, we will affect only a small percentage of the whole.

In my talk I will begin by outlining the Canadian Educational System so as to provide a background in which to set the Data Processing scene.

The Canadian Education System (See Diagram 1)

Elementary Education - from kindergarten to Grade 8 - commences at the age of 5 and ends at the age of 13.

Secondary Education - commences at Grade 9 and continues to Grade 12 or 13 (in Ontario and British Columbia Grade 13 is necessary for University-Bound students). Secondary Schools are "composite" - or comprehensive - and have from 1500 to 2500 students.

Usually there are 2 types of programmes - University-Bound programmes or Vocational.

In Ontario there are 3 branches within each programme. These are:-

Arts and Science
Business and Commerce
and Science Technology and Trades

In all branches of the University-Bound programmes a large core of common subjects is taught to all groups with options of a second foreign language or mathematics, business subjects or mechanical and technical courses depending upon the programme selected. In the Non-University-Bound courses much less emphasis is placed in the course on the core and more upon the branch chosen.

There is a 2 year secondary school terminal programme called the occupation course for those students who have difficulty in achieving the objective of the University-Bound or Vocational programmes.

An examination by the Province or by the University is a prerequisite for entrance to the Universities. University programmes consist of a 3 years general arts degree and a 4 years Honours Degree. Usually 1 year is required to obtain an MA after a Bachelor's Degree and 2 to 3 years for a Ph.D. The professions of law, medicine and teaching require a general BA or B.Sc. before commencing their programmes.

Colleges of Applied Arts and Technology are just being established in each Province to assist those students who want more background but generally do not wish to undertake a University programme. Programmes vary from 2 to 3 years depending upon the student's background and his selection of courses. The courses emphasize vocational need from a technical point of view.

Private schools are established in Canada but generally have few students unless they offer a specialized programme for a particular group such as French language schools in the Province of Saskatchewan. There are also a number of Roman Catholic primary schools.

Minimum school-leaving age is normally 16 years.

All elementary school teachers must register in a teachers college after completing the secondary school programme for at least one year of training. Most Provinces are attempting to update entry qualifications of elementary school teachers by suggesting that they should have some part of a University Degree. For a secondary school teacher a minimum of one year (at a College of Education) after the University Degree is usually required.

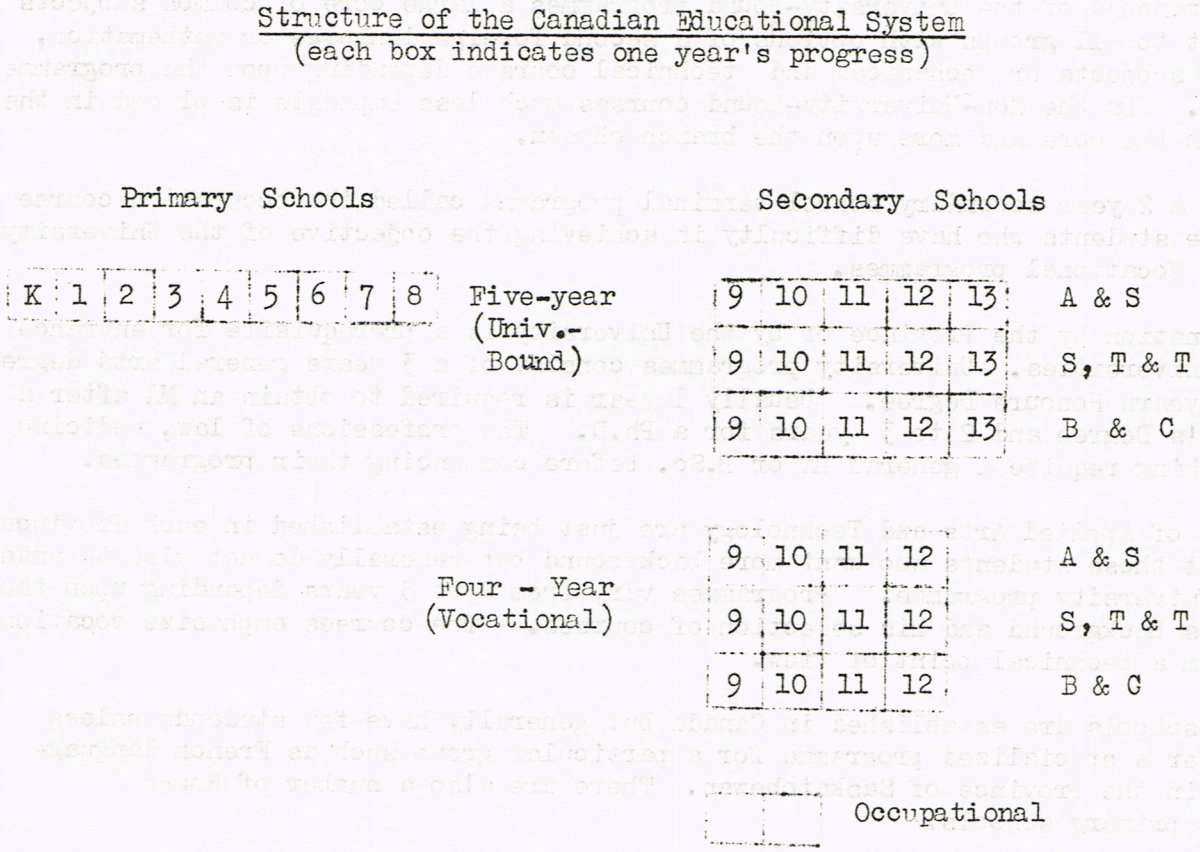
School Administration is the responsibility of the provinces as stated in the British North America Act of 1867.

The Federal Government takes no part in the administration of education but does offer financial support to the provinces.

The provinces have delegated their authorities to the Local Municipalities or cities except for overall policy.

The municipality elects a Board of Education separate from all other city administration. Their responsibilities include the following:-

Structure of the Canadian Educational System
(each box indicates one year's progress)



a) Sitting the schools
b) Building and maintaining the schools
c) Staffing the schools
D) Implementing and experimenting with courses outlined by the Province
e) Assisting and inspecting the staff and students to obtain the best educational environment
f) Budgeting and fiscal responsibility for the school to the electorate

The provinces through their department of education maintain responsibility for curriculum and supervision. They also maitain an elaborate grant system to the Municipal Board of Education which helps the Board to implement specialised and experimental courses. The rest of the expense of the schools are the responsibility of the Local Board of Education and are usually paid for by a property tax.

My Personal History in Computing

I spent ten years as a school teacher, the early part of which was in Business and Commerce. I became interested in Data Processing in 1959 - at that time at the very beginning of its move into the educational system. The first school in Canada to install Unit Record machines did so in 1960. My own school H.B. Beal Secondary School in London, Ontario, installed Unit Record equipment in 1961. The machines were an IBM 514 and 402, together with key punches, but I felt it was already too late - the age of computers was here.

In February 1963 we installed an IBM 1620 computer. Its configuration was a reader, punch and central processing unit. The 402 was replaced by a 407 to provide off-line printing facilities. As a matter of interest, the Principal's request for funds to support the installation was accepted almost without query by the School Board. In the stunned silence which greeted his request for $78,000 the motion to grant it was put and passed; the Board then returned to its discussion on value for money of different types of stop watches.

We installed the 1620 with four ends in view:-

1. to teach computing to school pupils
2. to teach computing to night school pupils, - adults who need re-training because of the effect of automation
3. to perform certain school applications - report cards, student scheduling (not timetabling) etc.
4. to rent it out to outside users, and so ease the financial situation

In the matter of student scheduling the technique adopted was for the school Principal to prepare a preliminary timetable and for the students' choices to be run against it. The Principal would amend his timetable in the light of the inconsistencies shown up and the students' choices would then be run against the revised timetable. In the first year there was an 80% achievement, in the second 95% and the usual 4 man months of effort was reduced to two weeks.

Dr. Gottlieb at the University of Totonto has, I believe, solved the timetabling algorithm - see the latest edition of the Computer Journal. However, the programming has yet to be done - and it is to do this jointly at the University of Toronto and the Ontario Institute for Studies in Education. It is likely to require the use of large computers.

My own detailed data processing knowledge was gained by attending IBM courses during Summer vacations.

I left the H.B. Beal school to join the Althouse College of Education, University of Western Ontario in July 1965 as an assistant professor in the Business and Commerce Department. My responsibility is the training of teachers in Data Processing.

Data Processing in Schools

With the great inroad of the computer and data processing equipment, the Department of Education in Ontario felt that all students should be aware of this technology and the impact that this will have on their lives. Therefore courses should be established at the secondary school level in this area. The objectives of establishing data processing courses are as follows:-

a) for those students who are University-Bound the computer should be a tool to solve their problems.
b) for those students who are Vocationally oriented a knowledge of the computer and other data processing equipment will assist in obtaining employment.
c) for all students a knowledge of what a computer is and what its functions and limitations are is essential for the computerised world of tomorrow.

In 1964 the Ontario Department of Education convened a Data Processing Curriculum Committee, composed of practising teachers, officials of the Department of Education and representatives of business machine manufacturers.

The Curriculum Committee discussed approaches to Data Processing for two years. The final report, called Revised Program 33 (RP33) was completed and published only in September 1966.

The courses are as follows:-

For Vocational students:

A Grade 10 course which discusses all different types of Data Processing equipment and is designed to show the need for a systematical approach to solve information problems; it is just problem solving and has no vocational intent.

A Grade 11 course which consists of basic programming and is different from most programming courses since it stresses the need to communicate with the machine. It uses a language like FORTRAN, COBOL or PL/1 as a vehicle to communicate, nothing more.

A Grade 12 course deals with the fundamentals of systems design outlining the problem to the student and asking him to prepare a systematic solution from Input to Output.

Primarily, the courses listed above are for students registered in Business and Commerce, but will apply equally well to those in the other branches of Arts and Science, and Science Technology and Trades.

For University-Bound students:

A computer concepts course is designed for Grade 10 to make students aware of the history of computers, flow-charting and programming. It is expected that they will be able to make use of the knowledge given in this course in other disciplines such as mathematics, science and even the humanities.

At the moment most of the effort is being directed towards the four-year streams- i.e. not the University-Bound pupils. The intention is that the University-Bound students should grasp enough of the potential of computing at Grade 10 to enable them to appreciate the need for it, and to make efforts to use it, in their later studies. The mathematics orientated pupils are not being forgotten - for example, the school Mathematics Study Group is experimenting right now with the use of computers.

In 1966, 10 schools started to teach computing on the lines laid down in RP33 (which became generally available only in September 1966). In 1967 there will probably be about 100 and hopefully in 1968 all the 600 secondary schools in Ontario will be implemeenting the programme.

Teachers are being trained now. For example, at the Althouse College of Education last Summer, 120 qualified teachers took an initial course and many more are expected this Summer. Most of these teachers are experienced and already qualified in some other discipline.

Computer Availability.

There are, at the moment, 10 schools which have computers. The H.B. Beal school has supplemented its IBM 1620 with a Honeywell 120; the other schools have IBM 1130's.

The Provincial Department of Education assists with the provision of computers for schools. Upon request it is willing to give 75 % of the estimated amount (between $ 80,000 and $ 110,000) provided the municipality gives the other 25 %. The grant is not given automatically - a proper case must be made and evidence must be brought that sufficient preparation is being undertaken for a successful installation.

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The M.E.I. Computing Project.

by M.A.Bloxham (Harrow).

One of the results of the change of emphasis of mathematics at University level, and particularly in the uses of mathematics in industry, was the setting up in 1961 of the standing Conference on Mathematics in Education and Industry. A result of this conference was the founding of the North London Schools project under the leadership of Mr. B.T.Bellis, then head of mathematics at Highgate School, now headmaster of Daniel Stewarts College in Edinburgh. The aim of the project was to establish links between schools and industry by having teachers visit firms to discover what mathematical ability was needed at the different levels, what opinions were held by the personel on their own mathematical experience, particularly at school, and what they thought should be done to remedy any defects in the system.

These visits continue during 1963 and 1964 and committees were then set up to consider the views collected and to design new syllabuses at A level. There were appointed by the Oxford and Canbridge Board who agreed to examine them in the single and double subject Mathematics. The first exams were taken by several schools this July (1967).

The principle new recommendations for inclusion in the new syllabus were the use of vector methods and linear algebra, numerical analysis, probability and statistics. Also included was some work on computers and computing.

In the Pure Mathematics there is a section on "The idea of a programme of calculation. The preparation and interpolation of a simple flow diagram." The numerical analysis which follows this can be best taught using flow charts, and if possible by taking the next step and writing programs in whatever language the teacher prefers. This inclusion will depend on whether time can be found to teach the grammar of the language, but it has been found very beneficial to the pupils if this approach is used. The idea of iterative processes and tests for accuracy cease to be just dry procedures when used in programs. Pupils have shown far greater interest and reached greater understanding of convergence if they can write their own programs to print out successive values of a variable until the error is sufficiently small. This applies to the solution of polynomials and other equations in one variable, as well as integration by Simpson's Rule.

The Applied Mathematics syllabus has a Topic II at S-level containing some work on Computational Processes. This has sections on the analogue computer, parts of a digital computer as well as more specific ideas on programming and logic circuitry.

While noting the good points of the syllabus there are several instances where it will need some revision in due time. The examiners this year fought shy of anything to do with flow diagrams and had very little on iterative methods. It is more difficult to set a question, not involving mere knowledge of facts, on storage methods and analogue processes.

The allocation of topics to A or to S level appears arbitrary at times. Why nested multiplication and linear interpolation are considered as S topics, while Newtons method or the $x = f(x)$ method of solving an equation are A topics, is not easy to understand.

As with most modern syllabuses, the distinction between Pure and Applied Mathematics becomes impossible to draw, and some topics, such as differential equations, appear in both camps.

However the syllabus is a start to the introduction of computers and mathematical computing and its effect on school mathematics.

British Petroleum, which was a leading spirit in the original M.E.I. Conference decided to back the study of computers, and the computing side of the syllabus in particular, with some more practical assistance. In 1966 they installed their new 1905 computer at B.P.House in the City and as there was some spare time on it, they most generously offered to back a postal system of running programs for M.E.I. schools.

An interpreter was loaned free by the B.P. retail division of Shell-Mex and B.P., and installed at Harrow and a scheme of operations evolved. Now, any school in the project which wishes to participate must equip itself with a card punch. Programs are written and punched at the school, then sent to Harrow to be interpreted. These are then returned to the school for checking and corrections, after which if only a few cards are uninterpreted, the programs are sent to the computer. The cards are returned together with a listing, any resulting print out if there were no errors in compilation, trace for errors during running if any, and comments from the computer manager.

In practice the programs are away from the schools for between 7 and 16 days. This is a long time, but one must remember the time in the post at each end, standstill at weekends, the low priority on a commercial computer and the waiting time for comments and analysis from a very busy staff. Under these circumstances it is reasonable.

At present four schools are using the system, all programs being written in 1900 Fortran. Other M.E.I. schools are using Algol and have local arrangements.

B.P. were again very kind when they provided facilities including generous time on the computer, for a three-day programming course for teachers. This was run by teachers and was for beginners to learn Fortran and those with some experience to get more practice. It is hoped to run another one next year.

Apart from many programs on commercial analysis, in amd out of the syllabus, the pupils have written some on more original topics such as 'An analysis of Lennon-McCartney music', by differences, or 'Forecasting the possible F.A.Cup winners' by weighted means, or 'Pairing girls and boys for dates' by comparison of 'data'. Various classical sequences have been shown to converge very slowly, such as $(1+\frac{1}{n})^n \to e$ as $n \to \infty$ (correct to only 4 S.F. when $n = 5000$), and Wallis's formula for calculating π. An interesting sequence of numbers was obtained by calculating

$$\sqrt{(1+\sqrt{(2+\sqrt{(3+\ldots\ldots+\sqrt{n})\ldots)})}}$$

when n had reached 14. The task of using this limit has been unfruitful and suggestions would be welcome. However it did remind us that in the U.S.A. if not elsewhere, the computer has been used to find many interesting results and that the analysts are unable to prove these facts enough to keep pace with the flow.

The project has been going at full power for just under a year, but already considerable interest has been aroused in mathematics and computing at the schools concerned. So far the effort has been well worth while.

M.A.Bloxham.
Harrow.

OPERATIONS RESEARCH - SLAVE OR MASTER OF THE COMPUTER

Operations Research, the design of management systems, and data processing are the three complementary tools for improving the standard and reducing the cost of decision making in business and industry. However, as the power of computers has increased, so operations research techniques have become subordinate to data processing, and have lost their original comprehensive approach.

This is the theme of a paper to be presented jointly at IFIP Congress 68 by M. Hubert Le Boulanger and M. Hervé Gourio, both of the Direction Scientifique of the Société d'économie et de Mathématique Appliquées (SEMA). They will describe how operations research has become oriented to the analysis of large problems through computer-based simulation methods, and will discuss the implications of a more general .OR. approach on future developments.

IFIP Congress 68 - the premier event of the international computing calendar - is to be held in Edinburgh from the 5th to 10th August, 1968. It is expected that about 4,000 computer experts including the leading computer designers and users from all parts of the world will attend.

DEVELOPING SIMPLE LANGUAGES FOR COMPUTER INTERROGATION

I.C.T. Computer for Advanced Programming Research

The Ministry of Technology is now using an I.C.T. 1902 computer for research into languages for information retrieval at the Royal Radar Establishment (Malvern) Mathematics Laboratory.

The aim of the Malvern team is to design computer programs which will enable users such as administrators, nurses or policemen to communicate directly with their computers without having to call in skilled programming effort. In information retrieval, for example, it must become possible for users to express requests in a simple, direct and flexible manner.

One solution is to provide a set of stock questions which users are allowed to ask, but this is inflexible and ill-adapted to growth. Another solution, advocated at R.R.E., is to design computer programs which analyse sentences or questions by referring to a pre-arranged vocabulary and set of grammar rules. This offers vastly increased flexibility and enables vocabulary and grammar to be easily extended bt the user himself. Different vocabularies and, if necessary, different grammars, can be substituted for particular applications.

A current experiment at R.R.E. is for retrieval of catalogued facts about integrated circuits, and the user's language bears some resemblance to English. This particular experiment has been implemented on the R.R.E.'s central service computer, which is not well adapted to on-line research. However, the new I.C.T. computer will enable questions to be put directly from an interrogating typewriter without the intervention of punched cards or paper tapes. Exchangeable disc stores will hold catalogues of facts, vocabularies and grammars, and will enable rapid responses to be obtained.

With this new installation, the R.R.E. language research section becomes one of the few teams in Britain to be equipped with a special computer for advanced programming research. The team employs Dr. J.M. Foster of Aberdeen University as its university consultant, and also hopes to collaborate with I.C.T. in this research.

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CONFERENCES AND COURSES

Enfield College of Technology

Computing Centre, Queensway,
ENFIELD, Middx. Tel:01-804-8349

This college will run five short courses during 1968, specifically for teachers or lecturers who wish to introduce a computer education subject into the curriculum.

The college has been active in this field for several years and experience from the four courses held in 1967 has suggested that the optimum course duration is four days. It was also found that the beginning or end of the spring and summer terms causes least interference with school routine

The enrolment for each group will be limited to twenty. The college will issue a list of suitable hotels to any person requiring residential accomodation convenient to the college.

"Fortran Programming"

(E1).Tuesday, January 2nd. ----- Friday, January 5th.
(E2).Monday, April 29th. ----- Thursday, May 2nd.
(E3).Monday, July 1st. ----- Thursday, July 4th.

Lecturers: Mr. N.E. Bowker and Mr. J.A. Williams.

A thorough treatment of Fortran will be given, with ample opportunities to write and run programs on the college computer.

"Logic Tutors and their Applications"

(E4).Monday, March 25th. ----- Thursday, March 28th.

Lecturers: Mr. N.E. Bowker and Mr. J.D. Cumbers.

These lectures and practical sessions will deal with the algebra of logic, and show the value of logic tutors in modern subjects st the school and further education levels.

"Computer Teaching Aids"

(E5).Monday, April 1st. ----- Thursday, April 4th.

Lecturers: Mr. N.E. Bowker and Mr. J.D. Cumbers.

This course will introduce the range of teaching aids developed at Enfield College to assist the teaching of analogue and digital computing, in all its aspects. Good opportunities will be given for practical work with the equipment.

The fee for each of the above courses is £4. All applications and enquiries should be addressed to the Academic Registrar, Enfield College.

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Isleworth Polytechnic,
Department of Business and Professional Studies,
London Road,
ISLEWORTH, Middx. Tel: 01 - 560 - 3331

(a) Course for Trainee Computer Personnel in Business.
12 weeks full time. January to March, 1968, Fee = £40.

(b) Systems and Procedure for Computers. Fee = £4.4.0.
Eleven weeks from January 9th. 1968, Tuesdays, 7 - 9 pm.

(c) Introduction to Computers and Data Processing. Fee = £4.4.0.
Eleven weeks from January 10th. 1968, Wednesdays, 7 - 9 pm.

(d) Cobol Programming Language Fee = £4.4.0.
Eleven weeks from January 10th. 1968, Wednesdays, 7 - 9 pm.

(e) Principles and Practice of Computer Progrmmming. Fee = £4.4.0.
Eleven weeks from January 11th. 1968, Thursdays, 7 - 9 pm.

(f) Computers and Modern Management Techniques. Fee = £4.4.0.
Eleven weeks from January 12th. 1968, Fridays, 7 - 9 pm.

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C - E - I - R Education Centre.
Gillow House,
5, Winsley Street,
LONDON, W.1. Tel: 01 - 580 - 5899.

A number of full-time short courses are offered by this company. Outline information is given below:-

Course Title	Duration	Fee £
Fortran	4 days	40
Survey of Operational Research	1 week	75
Management in a Computer Department	1 week	75
Management Appreciaiion of Programming	3 days	45
Network Techniques	1 week	75
Network Analysis	1 day	15
Selection and Installation of a Computer System.	1 day	15

Course Title	Duration	Fee £
Management Introduction to Computers	3 days	45
Time Series Analysis	1 week	100
Planning the Computer's place in the Company	1 day	15
Operational Research Course	3 weeks	Not given
Computers in Business Management	1 day	15
Linear Programming	1 day	15
Survey of Operational Research	1 week	75
Production Planning and Stock Control	3 days	45
Network Techniques	1 week	75

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Computer Education 1967

(British Computer Society, 12/6).

Contents.

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Education of Systems Analysts.
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Book Reviews.

The first issue, of what will be an annual review, is essential reading for all in the computer education field. The booklet contains a wide range of information, from details of computer science courses (an excellent feature), through the proposed B.C.S professional qualifications, to computing in school.

The computer training aids article is an unfortunate attempt to update an earlier booklet. Although it gives useful information on a few items, it is hoped that future issues will cover the entire range (as is done in the other articles). A complete guide is so useful when choosing equipment.

N.E.B.

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The B.C.S. First National Symposium on Logic Design.

Reviewed by R.B. Matthews (Enfield College)

The symposium, which was held at Reading University on 7th July, 1967, was organised by the British Computer Society Study Group in Logic Design. Nearly eighty delegates, from industry and education, attended the symposium and the eight papers which were presented covered a variety of topics in the field of logic design.

The first paper, which was "Logic Design with M.O.S. Array Integrated Circuits" by Dr. R.C. Foss, (The Plessey Co. Ltd.,) considered the effects of M.O.S. technology of logic system design. A single chip can contain, for example, seven binary counters and about thirty NOR gates. This represents a highly complex logic function and a new approach to system design is required if the full potentialities of the technology are to be realized. An important factor when considering the scale of integration is the conservation of interfaces and the design of M.O.S. arrays requires the close co-operation of circuit and logic designers.

In "An extension of binary minimization techniques to ternary equations", S.L. Hurst (Bath University of Technology) described how graphical and algebraic methods, familiar in binary minimization, can be applied to ternary minimization. The use of a Karnaugh-type map was considered but this becomes difficult to visualize for over three variables. Reading the map is also difficult since it is impossible to maintain adjacencies between the three values of all three variables in a two-dimensional layout. The use of a three-dimensional (unit distance) diagram overcomes this problem and for functions of up to three ternary variables this is the most successful method. A fourth-order hypercube, however, is completely impractical for minimization purposes and an algebraic/numerical process must be used. The method described in the paper is an extension of the familiar Quine-McCluskey method used for binary functions. Examples were given to illustrate the three minimization methods described in the paper.

"Adaptive Logic Circuits" by I. Aleksander and R.C. Albrow . (Queen Mary College, London) opened with a review of the work done on biological models, these being mainly analogue systems. A digital model for adaptive logic circuits was then introduced. This comprised a universal logic circuit capable of all the logic functions, the particular function at any instant being determined by a number of information bits supplied by a control memory. The control memory is a sequential circuit which has one or more input channels for updating signals. It is thus possible to 'teach' the system to provide a number of different logic functions in sequence. The paper contained six examples to illustrate the design of adaptive elements and networks.

In "Race-Hazards", by D. Zissos, (Liverpool Regional College of Technology) the effects and the elimination of race-hazards in digital circuits was considered. Methods of detecting hazards in combinational and sequential circuits were presented, an algebraic method being used for the former and tabular method for the latter. The probability of a race-hazard was discussed and an algebraic expression for the probability was developed. It was shown that any degree of reduction in this probability can be achieved. Race-hazards in combinational circuits can always be eliminated by the application of a blanking signal but it is not always possible to eliminate hazards completely in sequential circuits.

Mr K.J.Dean, (Letchworth College of Technology) in his paper "Some Applications of Controlled Shift Registers" described some novel methods of calculation and code conversion using shift registers. These included binary division, binary multiplication, a Gray to binary code converter, a binary to decimal converter and a binary to logarithm (base 2) converter. Each of these employed a controlled shift register and the paper concluded with the detailed design of one such register employing J-K flip-flops.

"The use of Roth's Decomposition Algorithm in Multi-level Design of Circuits" by D.F.Holman and J.R. Barnard, (English Electric Co. Ltd.) described the use of a computer for the design of a logic network. Repeated application of the algorithm results in a multi-level circuit (as opposed to the more usual 2-level circuit) the aim being to produce an economical circuit using a specified set of gates. The paper, which contained an explanation of decomposition theory, indicated the difficulty of this kind of design and showed that considerable computer power is necessary even for a restricted application of the algorithm.

A jig which automates the Quine-Mc Cluskey mimimization procedure was described by P.D.Hirst (Letchworth College of Technology) in "The Design and Use of a Jig for Minimising Logic Functions". The Quine - Mc Cluskey method involves considerable routine work in writing-out lists and checking-off pairs of terms which will combine, and even with relatively few variables a computer becomes necessary. The jig which was described and demonstrated can be used for functions of up to eight variables but the principle could be adapted for larger numbers.

"Computer aided design - a'logic drawing board' using the PDP7/340 "by P. Cross (University Mathematical Laboratory, Cambridge) was the last paper presented at the Symposium. It described the use of an on-line digital C.R.T. display and light-pen for the design of logic networks. The logic drawing board is intended to form part of a complete computer-aided logic system which will also include; the design files, the wire listing generator and an output plotter.

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DATAFAIR 67

" Why Computer Education in Schools "

September 26th 1967. Review by N.E.BOWKER

This conference brought together lecturers and teachers from throughout the British Isles. The contributors were full of enthusium and ideas, but there was a distinct feeling of a repeat performance of the 1966 Enfield Symposium. The Audience and speakers were largely the same (" The same old circus " to note an anonymous delegate.!).

If this impression is true, it is a pity. In as exciting a field as Computer Education new converts should be pouring in. Several delegates had not even heard of the Computer Education Group before the conference.

Another factor was apparent. Most delegates were mathematicians. This also is unfortunate, as several contributers pointed out. The breakthrough to the "Arts" staff must be mode, and soon.

A plea to the organisers of the next conference - pre-prints please, and more time to see the exhibits!

The chair was very ably taken by Mr. Bridger (Leicester Regional College of Technology).He made the task of fitting twelve speakers and a demonstration into four and half hours seem easy.

Dr J.J.B.Dempster (C.E.O for Southampton) introduced the conference, emphasizing that the schools must take account of the joint requirements of numeracy and literacy in the modern world.

Dr E.D.Tagg (Oundle School) told how his interest in the computer education was first stimulated by meeting an ex sixth former in the 1957 Oxford conference. This former pupil had programmed a computer to re-route the ships diverted by the Suez crisis-but had never met a computer in school.

He compared the change in way of life caused by the computer to that caused by the motor car. The car allowed us travel faster to places not normally reached, and door to door. All users need to know how to drive, how to choose a route, and where to go. Some users also need to know how to design and repair a car. Thus thought process were altered by the car. The parallel is obvious, and we have to orientate to the new thought process introduced by the computer.

At Oundle construction of models to discover computer processes was started ten years ago, and now logic boards and arithmetic units.

"Driving" was first taught in machine code, but now FORTRAN is used, "Destinations" are more difficult to define, but the aim is to get away from the current situation where "1967 Hardware and 1963 software are used to solve 1948 problems"

The school scheme is run by the Mathematics Department, and all past O-level students have three periods of Statistics and Computing per week, and a data processing Seminar. Problems were non-mathematical where possible - league tables and cricket scores for example.

Mr. M.Meredith (Towyn School) delighted the delegates with his demonstration of the application of the analogue computer in solving equations and obtaining the "feel" of a problem. He "Threw up a chestnut" using a large screen oscilloscope to show it's trajectory, and the effect of wind and air friction. He praised the Analogue Computer as a versatile teaching aid, for economic models as well as mathematical ones.

Mr.Wilkinson (Spennymoor Grammar Technical School) suggested that an early introduction to electronics broke the pupil from a mechanical view of the world. To this end, the building of comp-- uter units at an early stage was easy to start, and cheap. Pupils build from scratch, as no plans exist, and often become obsessed with the subject.

In Spennymoor, construction started as an out-of-school activity, and has progressed via sixth-form minority time to a lower school subject.

Equipment on display included a NOR logic panel, a Binary / Decimal Counter, and an arithmetic tutor. The next step is to build a programming unit for this tutor, giving a true computer,

Mr. Broderick (Royal Liberty School) believed that programming learnt at an early age could lead to insight into real problems, and a logical approach to problems. As such, the process was inherently educational

After initial experiments at Royal Liberty School, London University were asked for an A level subject in computing, to act as a 'spur', and after 2/3 of the cost of a computer had been raised, the L.E.A, found the rest. The computer cost £17000, and up keep exclusive of teaching staff salaries is £3500. It is in use 50 hours a week at present, on an 'open shop' basis.

Courses running at present; apart from the A-level course, are an experimental Management Science course for sixth formers covering linear programming, stock control, critical path analysis and accountancy,a C.S.E. course (requiring little academic knowledge) in programming and hardware, and eveniig courses for teachers and the public.

Mr. Goldstein (University College School) spoke of the advantages of programming knowledge for the mathmatics pupil. It gave insight into real problems, and incentive to generate new problems. The classroom atmosphere was improved by using realistic problems.

He considered that students required a mature outlook, and preferably 'O-level mathematics before entering a course. The course should approach real problems via mathematics, and interesting problems could come from co-operation with industry. A short turn round of programs was essential, together with a library of data, punching facilities and (at present) pre-correction of programs by staff.

Mr. Pegg (Bedford School) pointed out the basic difficulty that the "Arts" student has little idea of the use of a computer. They should be introduced to them, partly to prevent a continuation of the present situation where top executives throw out the ideas of the technologist, and partly in self-interest, as many programmers and systems analysts will be drawn from the "Arts" pupils.

He felt that the high level languages were too technical, and a new "school" language was needed.

At Bedford, a pre-O-level course in logical processes is followed after O-level by an outline of computer processes, and the social and economic effects. Those who wish are taught programming. The use of film and television makes the course interesting to non mathematicians.

Mr. Farringdon (St. Lukes College) discussed the role of the College of Education. Most computing teachers would come from this source. He believed that computing should be in the "core" course, discussing social and economic effects, as well as the use in administration. The C.O.E. might be the local computer centre.

Dr. Summersbee (Brighton College of Technology) suggested that the only way out of the situation caused by lack of funds was the use of multi-access computers. Each school only had to buy a teleprinter, and then effectively had a flexible desk calculator which could in addition handle data processing and records, with a simple programming language. The addition of a display unit could allow visual displays to be used.

This talk was followed by a demonstration by I.C.T. of an on-line link to their Putney Computer. There were six such links in the Datafair.

Mr. Cooper of I.B.M. diccussed computer aided learning. He said that the equipment is available, but there is a lack of users. although experiments are in hand in the U.S.A. He showed a film of one such experiment.

Miss D. Law (I.C.T.) woke the conference up, giving "hand grenades to the mathematicians".

She saw the future as large multi-access computers in the colleges of Technology and Polytechnics, linked to schools and colleges. The Colleges of Technology led the way at present in assisting schools.

Miss Law then surveyed the careers structure in the industry, saying qualifications were less important than a lively mind, and that one third of programmers were women!

There were gaps in the qualification structure on the commerce side, partly caused by the C.N.A.A. insistence on mathematics as one subject in a computing degree course, but she foresaw the gradual replacement of the current "Arts" graduate intake by computer science graduates.

Any college without a lecturer in computing was unequipped, and she concluded by saying that computing should by taught as a discipline in it's own right, as basic as the "three R's". It was the fourth R and should be considered as such.

The Development of Computer Studies in Higher Education.

Datafair 67 Southampton University
27/9/67

Review by J.A. Taylor. (Enfield College)

This symposium held in the middle of what appeared to be a highly successful 'Datafair' at Southampton University was remarkable for two things. Firstly it brought together under one quite small roof computer educationalists from the whole spectrum of higher education - the Department of Education and Science, The Ministry of Technology, The National Computing Centre, The Universities, The proposed Polytechnics and Industry were all represented - and enabled then to exchange ideas and problems informally. Secondly the phrase 'Commercial Data Processing' was constantly being repeated both by the speakers and from the floor whilst the phrase 'scientific computing' was heard hardly at all.

This last point, particularly in relation to Systems Analysis, seemed to dominate the morning session and the impression was given that higher education in the realm of Computer Studies was likely to undergo a radical change of emphasis. This point was further underlined by Mr. Aylward of the Ministry of Technology who quoted from a recent U.S. Report on computers that Electronic data processing "has been growing for years and has nearly reached infancy".

After a welcome to a full capacity lecture hall of delegates by Mr. M. Bridger, Chairman of the British Computer Society Education Committee, the session was opened by Professor G. Black, Director of the National Computing Centre.

Professor Black referred to the serious gap that had opened up between supply and demand for trained and experienced people to install and make effective and economic use of computing systems being delivered now and in ever increasing numbers in the future. The closing of this gap was vital as the Nation's competitive position within the world may well be closely related to her ability to make good use of modern techniques of which computing was probably the most important. There was a large demand for the product of a 'marriage' between the man with Computer experience and the man with broad commercial experience. It was one of the jobs of higher education to bring this marriage about.

Mr. R.D. Aylward of the Ministry of Technology continued by giving a short paper on the Requirements for Computer Staff.

Mr. Aylward began be restating the importance of computers to Britain's ability to hold and improve her technological world position. He divided the world of Computer Education into five areas:-

1) Electronic and Electro mechanical Engineering.
2) Soft hardware and communications.
3) High level Systems programming.
4) Systems Analysis and Design.
5) Management education.

From these five areas Mr. Aylward singled out Systems Analysis and Design as being the area where the gap referred to earlier by Professor Black was at its most severe and also as the area least likely to be affected by technical development. The current load of teaching was then summarised:-

a) computer manufacturers - bearing an unfair burden and obviously biased training to their own equipment.
b) consultant organisations.
c) computer users themselves - only the largest able to support comprehensive schemes.
d) public education sector - both Universities and Technical colleges currently providing very little.
e) schools - only a very few poineer schemes in existence.
f) National Computing Centre - providing course packages and running pilot courses.

Public higher education should be prepared to accept a much greater load of this teaching and should work toward the ultimate aim that no student should leave a University or College without some idea of the use of computers no matter what his discipline. Mr. Aylward also thought that Universities should play a part in providing high level Systems Analysis and Design courses of a practical nature as suggested in the Robbins report. The human relations problems raised by the implementation of computing systems should also be covered widely within Social Science courses.

All this would require co-operation at top level between the various organisations concerned - Government departments, Higher Education bodies and the British Computer Society. This was being worked towards.

The possibility was foreseen by Mr. Aylward of Computer oriented colleges devoted to Computer studies although such institutions would operate in parallel with and not in place of existing institutions. One function of such establishments may be the training of teachers.

Mr. F. Land of the London School of Economics continued the session speaking on the subject of 'The training of Systems Analysis'.

Mr.Land commenced by defining Systems Analysis and mentioning a number of common problems associated with the installation and use of the Computer Systems. He instanced an extreme example where a complete manual system had grown up unofficially and unplanned 'beneath' a Computer System with the result that the Computer System became worthless. He suggested that these problems and failures

were largely due to inadequate Systems Analysis and Design.

The broad headings of a typical syllabus for the training of Systems Analysts was then discussed:-

a) Communications:- fact finding and recording, presentation and 'selling' of procedures, teaching and instructional techniques, clarity and logicality of expression.

b) Business:- accounting methods, security and protection of information, costing and work study, marketing. Knowledge in some depth of these areas was vital if an analyst was to be trusted and have any chance of 'selling' his procedures.

c) Computing Methods:- constraints of equipment including peripheral and fringe equipment such as punched card, keyboard accountancy and paper handling machines. Programming problems and techniques. File processing methods and economics.

d) Systems methodology:- stages to follow, mapping methods, specification writing, cost justification, standards, coding, form design implementation.

All four of these areas should be taught on a practical plane and case studies should play an important role in any course.

Mr. Land freely admitted that a person familiar and competent in all the subject matter mentioned would be something of a superman but he was convinced that, provided a student had the right type of personality and approach to the job, the material listed would be adequate to act as a groundwork.

Considerable discussion resulted over this last point and some questions doubted the feasibility of producing such a man. There was also a number of questions concerning the provision of resources for the teaching of data precessing subjects generally. It was suggested by Mrs. M. Barritt that a large installation of a parallel nature to the Science Research Council installation at Chilton was required for carrying out research into data processing problems and providing overflow resourses to teaching establishments.

In taking the topic away from commercial problems Professor Buckingham pointed to the huge discrepancy between official estimates of 200 additional high level systems programmers required by 1 70 and the figure of £300 million to be spent on the production of software by that date quoted in 'The Times' recently.

For the afternoon session the symposium split into two separate groups - one to consider First degree and Post graduate degree courses and the other to consider the commercial and technical full-time courses. Since these sessions were concurrent a report on the second of these two groups only is possible.

Under the chairmanship of Mr. D. Toose, Department of Education and Science, Mrs. M. Barritt of Edinburgh Regional Computer Centre spoke on the Basic Courses City and Guilds 319/320 and the RSA course.

Mrs. Barritt began by placing the City and Guilds courses in relationship to the new developments in Computer Education which were now becomming clear. The two courses, 320 logically following 319, could be seen as preliminaries in a career structure to any form of Systems Analysis course or as a possible first step towards British Computer Society professional qualification. The two courses should certainly act as selection paths whereby promising students were recognized and passed on the appropriate level. It was important also not to see the RSA course for operators as preliminary and lower level course to City and Guilds. It should rather be considered as a alternative but parallel path.

Mrs. Barritt then turned her attention to the problem of commercial acceptance and recognition of the courses. One of the main criticisems levelled at the courses was that they lacked any convincing commercial influence. This, it was thought, was largely due to the great difficulty in describing the syllabus in such a way as to ensure that teachers attached the required meaning to many of the topics. It was also due to the complete lack of research into what was truly needed by the commercial data processing world. This situation was however being rectified and the syllabus had undergone changes which were to be published very shortly.

The new syllabus of the two courses reflected a slight change away from the mathematical/statistical content toward more elementary systems analysis. It had been found that the documentation and communication standards of examination submissions had been much lower than had been hoped and this area of work was to be emphasised.

Mrs. Barritt concluded by stressing again her conviction that a large data processing utility installation general to computer training institutions was urgently required and pressed that at least one such installation should be shared by the polytechnics of the future.

Mr. K. Pendray of British Rail completed the formal progrmmme from speakers by giving an account of the City and Guilds conversion course 383.

The aim of the City and Guilds 383 course was to retrain those who already had wide business experience in management positions and communicate to then sufficient computing knowledge to enable them to make good use of computer installations. This could only be achieved if the right men could be persuaded to come

on the courses. Such people could go a long way in temporarily plugging the gap mentioned earlier. Mr. Pendray thought that there was a danger if the Systems Analyst with a narrow computer background was not modified by people with the business 'know-how' as well.

The relationship of City and Guilds 383 with the Nat onal Computing Centre Systems Analysis course was pointed out by suggesting that a trained Analyst would be twice as effective if talking to a trained manager than an untrained manager. The courses were compatible to each other im providing computer education for both sides of the systems problem.

A further unscheduled account was then given by Mr M. Bridger, Chairman of the British Computer Society, on the latest information regarding professional qualifications within the B.C.S. Mr Bridger was not able to add significantly to the progress report given in the Computer Bulletin Review of Education (June 1967) other than to say that exemption terms for both the City and Guilds 319 and 320 courses and the National Computing Centre Systems Analysis courses were being considered and that a board comprising the Department of Education and Science, the Scottish Educational Department, the City and Guilds institute, the Royal Society of Arts and the British Computer Society were looking at the problem.

A discussion followed chiefly related to delegates experiences in operating the City and Guilds courses over recent years. The general impression appeared to be that after a hesitant start fairly rapid expansion was taking place and that the chief problem was gaining the support and confidence of employers. This was however being tackled realistically in many areas.

The symposium as a whole was exeedingly valuable in consolidating and clarifying the most recent events and trends in the computer studies field of Higher Education, particularly with reference to Systems Analysis. There was however very little to appear that could be described as emerging from the symposium and nothing at all relating to the key problem of trying to fit on essentially inter-disciplinary subject into an educational system based on separate disciplinary lines.

It is quite likely however that, as it is said within the United Nations, more may eventually come out of the chance conversation in the corridors during tea than from the proceedings of the conference itself.

J.A. Taylor.

RANDOM THOUGHTS ON THE PORTSMOUTH S/A COURSE

OR

"LET ME THROUGH, I AM A SYSTEMS ANALYST"

Two o'clock on a humid September afternoon; thirteen tired lecturers attend another lecture in the series, "Total Systems Concepts and the Role of Multi-programming and Random Access Devices in the Mobility of Information and Decisions in Middle Management".

"And so gentlemen, we see that the horizontal flow of information within the structure of the original system can only produce a Hyper-Planar distribution of unco-ordinated data, resulting in inefficiency, redundancy and....."

The speaker's voice drones on and on. A brass sun throbs in the sky; leaden eyelids close, open and close; heads knod. The voice continues in time with the loud wall clock. Shadows change, the air is warm and heavy, and the voice fades to a timeless realm of space. Sounds move with colours, shapes blend.....

12,000 Systems Analysts by 1970, or was it 1,970 Systems Analysts by 12000 AD? I suppose they mean the same thing. Who would want to be a Systems Analyst? The only one advantage associated with the job is the money, but who wants money to pay doctor's fees to cure ulcers produced by worry? I certainly do not. Perhaps the worry is not too much to put up with, or a stomach full of ulcers will be a status symbol in ten years time, one never knows.

What is a Systems Analyst? Well,

He is a man in his early forties or fifties even though he celebrated his 32nd. birthday last week.

When he comes home from the office he kisses his wife and tries to remember her name, but normally refers to her as "Dear" or "Pet". After dinner he puts his dog on and takes his slippers for walkies.

He spends 95% of his time wondering why he became a Systems Analyst, and the other 5% worrying about how much time he spends wondering why he became etc.....

He is a lonely man with very few friends; this is because every time he makes a new acquaintance, he eventually sacks him or makes him redundant.

He is very cautious, a decision is only made with reference to a Flow-Diagram with a Critical Path Analysis, thus planning breakfast becomes rather messy, with marmalade on his activities.....

....."I'm sure that you will all agree, that the flexible structure is to be preferred. And there gentlemen, I will conclude today's lecture".

"Good morning, gentlemen, the time is seven-thirty, the time is seven-thirty." The cheerful voice echoed along the corridors shattering the morning silence with its unwanted information. Up to that day I had never believed that such a time could exist in the morning, but we live and learn. If only Mother Nature could have arranged that the day started with the evening and ended with the morning, instead of the present arrangement, life would be much more enjoyable. I just cannot wake up to the sound of birds singing, the sun shining and a cold breakfast.

After the 17 course breakfast;

1 cup of tea
1 saucer of tea
6 plates
1 knife
1 fork
2 spoons
1 egg
2 toast
1 chair
1 table

we could face anything that fate had to offer during the day.

The first lecture was to have been Memory Systems, but the Lecturer had forgotten the date and thus failed to arrive on time, however, the second lecture on "Fact finding and Interviewing" was most interesting.....
"Good morning, I am a Systems Analyst"
"Don't worry, I won't tell anyone."
"Yes, well, er. I have been hired by your present employer to discover if you require a Computer."
"We don't."
"Well thankyou for your co-operation, good day".
And so another progressive step is made by industry.
Or, consider this.....
"Well, this is it, the result of four years continous research. My new system will save the firm £500,000 per year, now to show J.B."
".....as you can see sir, the new system will require an initial outlay of £200,000 but after two years we will be saving £500,000 per year."
"RUBBISH!"
Never mind.

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The systems Analyst spends the majority of his life asking questions, but there are three questions he keeps asking himself:

Why don't I become a bus conductor?
Why is there a thing called management?
Why?

Pity the S/A for he is a Revolutionary in a society that is tired of revolutions.

----- O -----

"There's a thing called Operational Research," he said.
"Christopher Robin tried to teach it to me once, but it didn't".
"What didn't?" said Julian.
"Didn't what?" said Piglet
Pooh shook his head.
"I don't know," he said. "It just didn't. What are we talking about?"
"Pooh," said Piglet reproachfully, "haven't you been listening to what Julian was saying?"
"I listened, but I had a small piece of fluff in my ear. Could you say it again, please, Julian?"
Julian never minded saying things again, so he asked where he should begin from; and when Pooh had said from the moment when the fluff got in his ear, and Julian had asked when that was, and Pooh had said he didn't know because he hadn't heard properly.....

.....a brass sun throbs in the sky; leaden eyelids open and close.....

"by Anne Erlist"

BOOKS ON COMPUTING FOR SCHOOLS.

List prepared for Working Party No. 4 of the British Computer Society Education Committee.

1). Background reading on Computers and Programming.

F.B.Lovis. "Computers I" and "Computers II". Edward Arnold (4/6 each). Age 11 - 16. Number scales, parts of computer, flow charts, linear programming, uses of computer.

D.E.Mansfield and M.Bruckheimer. "Mathematics, a new approach. Book 4". Chatto and Windus (1965). 'O' level. Chapters on logic, circuits, flow charts, and computer programming.

F.J.Budden. "An introduction to number scales and Computers". Longmans. (1965, 12/6). Age 11 - 18. Number scales in all guises, Simple circuitry. A basic code for programming.

J.P.Marchant and D.Pegg. "Digital Computers, A Practical Approach." Blackie (1967 27/6). Age 11 - 18. Simple practical explanation of hardware. Circuitry applications. Some programming.

K.S.Snell, J.B.Morgan, S.L.Parsonson and M.A.Bloxham. "New Mathematics Pamphlet 2". C.U.P. (1967 6/6). 'O' level. Chapters on logic, circuits and flow charts.

A.Battersby. "Mathematics in Management". Pelican (1966 7/6). 6th. form. Chiefly modern mathematical techniques. Chapters on flow charts and computers.

Scientific American. "Information". Freeman (1966 18/-). 6th. form. Mainly discussion on hardware and uses of computers.

R.B.Matthews. "Logic Tutors and Their Applications." Harrap (1968 21/-). Age 13 - 18. Demonstrations, experiments and projects. Digital computer principles.

F.Gruenberger and G.Jaffray. "Problems for Computer Solution". Wiley (1966 54/-). 6th. form plus. Some interesting problems, no solutions. Good for ideas.

A.Fletcher and G.Clarke. "Management and Mathematics". Business Publications (1964 55/-). 6th. form plus. Discussion of modern mathematical techniques.

Shirley Thomas. "Computers, History and Present Application" Holt, Reinhart and Wilson (1965 12/-). Age 14 - 16. General.

K.N.Dodd. "Computers". Pan Books (1966 5/-). 6th. form. Logic.

S.H.Hollingdale and F.C.Tootill. "Electronic Computers". Pelican 1965 7/6). 6th. form. Comprehensive covering of all aspects of computers.

J.A.Postley. "Computers and People". McGraw-Hill (1963 12/6). 13- Computers in Society.

T.E.Ivall. "Computer Principles and Applications". Iliffe and Sons (1960). 13- General. Analogue and Digital. Historical.

2). Mathematical programming and relevant analysis.

D.M.McCormick and M.G.Salvadori. "Numerical Methods and Fortran". Prentice Hall (1964 65/-). Teachers / U6th. Introduction to Fortran plus analysis and programs. Exercises.

D.D.McCracken and W.S.Dorn. "Numerical Methods and Fortran" Wiley (1964 60/- P.B. 40/-). Teachers / U6th. Introduction to Fortran plus a lot of analysis and plenty of exercises. Programs.

K.A.Redish. "Computational Methods". E.U.P. (1962 30/-). Teachers. Analysis only.

D.P.Hartree. "Numerical Analysis". O.U.P. (1957 45/-) Teachers. Analysis only.

N.P.L. "Modern Computing Methods". H.M.S.O. (1961 21/-). Teachers. Advanced analysis.

Wooldridge. "An introduction to Computing". O.U.P. (30/-). Teachers / U6th. Mainly analysis.

B.Noble. "Numerical Methods Vol.1.". Oliver and Boyd (1964 10/6). Teachers / 6th. Analysis. Programming in a simple language.

Vol.2. Oliver and Boyd (1964 12/6). Teachers. Analysis.

3). Programming Languages.

D.D.McCracken. "A Guide to Fortran Programming". Wiley (1962 23/-). 6th. form. Fortran 2. Well written plenty of exercises.

L.Dale-Harris. "Fortran Programming". Merrit (1965 26/-).

B.A.Moon, "Computer Programming for Science and Engineering. Butterworth (1966 28/-). 5th. form. Fortran 2.

I.C.T. "1900 Fortran Handbook". I.C.T. (1966 26/8 with educational discount.) 6th. form. For reference.

I.C.T. "1900 Fortran Programmed Textbook Vols I,II. I.C.T. (1966 each 30/-). 6th. form. Spaciously set out. Teach yourself Fortran.

D.McCracken. "A Guide to Algol Programming". Wiley (1962 23/-). 6th. form.

K.Nicol. "Elementary Programming and Algol". McGraw-Hill (1965 30/-). 6th. form. A few exercises. Several good case studies, with flow chart and program.

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