THE UTECOM DIGITAL COMPUTER

by

R.G. Smart
School of Electrical Engineering
N.S.W. University of Technology

GENERAL

UTECOM is an English Electric DEUCE type computer, operated in the School of Electrical Engineering in the New South Wales University of Technology at Sydney. The DEUCE is a binary machine with a 32 bit word and operates in the fixed point serial mode. The input-output is an 80 column Hollerith punched card system. The memory has 402 words of Mercury Delay line storage, made up of single, double, quadruple and thirty-two word units, and in addition a magnetic drum of 8192 words capacity. The English Electric Company is at present developing a magnetic tape system for use with the DEUCE computers and it is expected that one of these units will be attached to UTECOM in the future.

HISTORICAL

The decision to purchase a digital computer for the University was made late in 1954. The Head of the School, Professor Vowels, planned to establish a large computing department, both analogue and digital, within the School to study the applications and design of electronic computing equipment. It was decided to purchase a digital machine and to gain operating experience with this before any large scale digital computer design was attempted within the School.

An order was placed with the English Electric Company early in 1955 and UTECOM, the fifth DEUCE type machine to be produced, arrived in Sydney on the 1st August, 1956. The machine was re-assembled with the assistance of the company and the official opening took place early in September. UTECOM has been entirely maintained and operated by the University staff since the end of October, 1956. With one exception, the present staff was trained in Sydney.

OPERATING SCHEDULE

From October, 1956 UTECOM has operated for 8 hours or more per day. A scheduled maintenance period averaging 2 hours per day is commenced at 9 a.m. For the remainder of the day and the evening if necessary the machine has been available for computing, programme testing and training purposes.

During the first few months of operation a considerable amount, over 30% of the total machine time, was devoted to the training of both programming and engineering staff.

Machine time has been made available to programmers on a generous and relatively flexible prior booking system, designed to give programmers rapid access to the computer. This method of operating inevitably wastes a considerable amount of machine time but enables the maximum amount of work to be achieved by the minimum number of programmers.

Since the beginning of December, 1956, UTECOM has been available for use by programmers for a total of 684 hours, that is, about 6 hours per working

day. This time has been utilised as follows :-

Productive Computing	24%
Programme Testing	56%
Demonstration	7%
Programmer Training	3%
Unused time	10%
	100%

Programme testing time is by far the biggest item and no decided attempt has been made to minimise this figure because the available machine time has been ample for the number of programmers using the machine.

MACHINE PERFORMANCE

UTECOM was fully tested before being shipped from England and the acceptance tests were repeated in Sydney. The installation of the machine included its re-assembly, a complete valve check, refilling of the Mercury lines and re-assembly of the Magnetic Drum rotor into its housing.

From the date of commissioning until the end of November, the amount of lost time and unscheduled maintenance resulting from machine failures was much less than 10% of the scheduled operating time. Since that date, engineer training and unscheduled maintenance have been logged as one item and amounted to 26% of the scheduled operating time.

No troubles occurred which could be described as settling down faults, except with the quartz crystal fittings in the Mercury Delay lines. Several failures occurred about Christmas, 1956 but since these were corrected no further Delay line faults have occurred.

During February, 1957, a combination of high humidity and water leakage into the air circulating system, caused an abnormal number of resistor failures. This period accounted for almost a third of the total down time to date.

SUMMARY OF TYPES OF FAILURE

Approximately 83 individual failures have occurred since October, 1956 during which time UTECOM has operated for an average of 40 hours per week, that is for a total period of 1300 hours.

Failures have occurred at the average rate of three per week, or only two per week if February is not included.

Of these 83 failures, 13 were of a mechanical nature, relays, switches, etc., and a further 10 necessitated electrical adjustment. Component replacements have been made as follows:-

33 valves (the machine has about 1400 valves)
35 resistors (19 wire wound, 16 high stability carbons)
12 condensers (mostly small lead through filter condenser)
5 diodes.

STAFF

Since December, 1956, UTECOM has had two maintenance engineers, three programmers and one operator. The present programming and operating staff is quite inadequate for the work on hand and investigations by the staff into computer applications have been limited as a result of this. The large programme library provided with the machine has been of great

assistance and the DEUCE interpretive scheme has also been used extensively to reduce programming time. The programming staff is at present being increased.

PROGRAMMER TRAINING

Two courses have been completed to date and a third is nearing completion, covering general aspects of high speed digital computing and UTECOM programming. The first of these was operated for the University staff and the other two have had a total attendance from outside organisation exceeding 90. The formal lectures of the present course will be finished in a few weeks and will be followed with tutorials in the computer laboratory. Those attending are encouraged to complete a programme as part of the course.

TYPE OF WORK COMPLETED

The type of work carried out in the laboratory covers a wide range. A considerable amount of statistical calculations have been done and many of these were programmed using the matrix algebra interpretive scheme. Only 18% of the total computing done to date has been for outside organisations, the remainder being distributed over the Schools of Mathematics, Applied Physics, Textile (Wool) Technology, Applied Chemistry, Architecture and Electrical Engineering within the University. The proportion of work for outside organisations is steadily growing.

Some of the projects being conducted on UTECOM are :-

Payroll.

In conjunction with the N.S.W. Public Service Board, a pilot scheme for determining the feasibility of doing a large scale payroll on UTECOM is being operated and the trial run will be done within a few weeks. The scheme operates with punched cards and includes sorting, collating and tabulating with standard 80 column Hollerith equipment. The overall scheme accepts the standard information, and information about changes in salary, deductions, tax allowance and overtime for each employee and after the final punched card operations produces the payroll, pay advice slips, cheques to individuals, banks and paymasters and allocates the charges against various accounts. At the end of each year the tax certificate can be tabulated.

Electrical Network Synthesis.

The application of a digital computer to electrical network synthesis is being investigated. The work is directed towards the synthesis of the components of a network (filter, equaliser etc.) given its impedance functions.

Induction Motor Design.

A member of staff of the School of Electrical Engineering is investigating the application of the computer to the performance calculation of a single phase capacitor induction motor. It is planned to extend this work to the complete design of induction motors.

Hydrology.

The computer has been successfully applied to the derivation of the Unitgraph for rainfall catchment areas and other aspects of hydrology are being investigated in conjunction with the School of Civil Engineering. The Unitgraph derivation which is required in connection with flood control and the design of dams can be determined either by the usual Collin's method for one storm or by a least squares fit to all the data available for the catchment area.

Linear Programming.

The application of linear programming to optimisation problems in distribution and system organisation is being investigated. Programmes for use in this work are now being prepared and other DEUCE programmes prepared in England will be available soon.

Market Analysis.

A programme is being prepared, which in conjunction with other DEUCE programmes will carry out the analysis of data punched into 80 column cards. The data can be sorted in a number of different ways in one run and a variety of calculations done on each cell. A considerable saving in time can be achieved over doing the same work by a combination of the use of mechanical punched card equipment and manual calculation.

Programme Library.

The English Electric Compnay operates a scheme for the interchange of programming information between DEUCE users. There are nine of these machines at present in operation and subroutines and programmes of general interest are collected and published in a standard form to facilitate their general use on DEUCE machines. Approximately 300 complete programmes and 200 subroutines are included in the library at present, and new routines arrive in Sydney at the rate of about a dozen per month.

General Policy.

Charges are made for productive computing on a time hire basis. The University aims to develop the application of electronic computing equipment in Australia and in some cases has been able to carry out preliminary investigations and make a trial run without charge for a new computer application. To date it has not been necessary to charge for programme testing time but this will not continue indefinitely.

DISCUSSION

Mr. B.Z. de Ferranti, I.B.M.

Could you give measures of the differences in speed between optimised and non-optimised programmes on your computer?

Mr. R.G. Smart (in reply)

One programme on which I can give figures is a 30 x 30 matrix inversion to solve a set of linear equations. Using binary input this takes $2\frac{3}{4}$ min. Using decimal input and non-optimised programme this could take as long as 4 - 5 min.

Mr. Wilkinson N.P.L.

As regards the term optimising I feel this is somewhat misleading at times. It implies that one goes out of ones way to optimise a programme.

In practice, one has to do the best one can depending upon the machine time available. For example, I have programmed a routine to do a similar process to that described by Mr. Smart and this programme, neglecting input-output, takes time varying between $\frac{3}{4}$ of a min and a min to do a set of 30 simultaneous linear equations.