

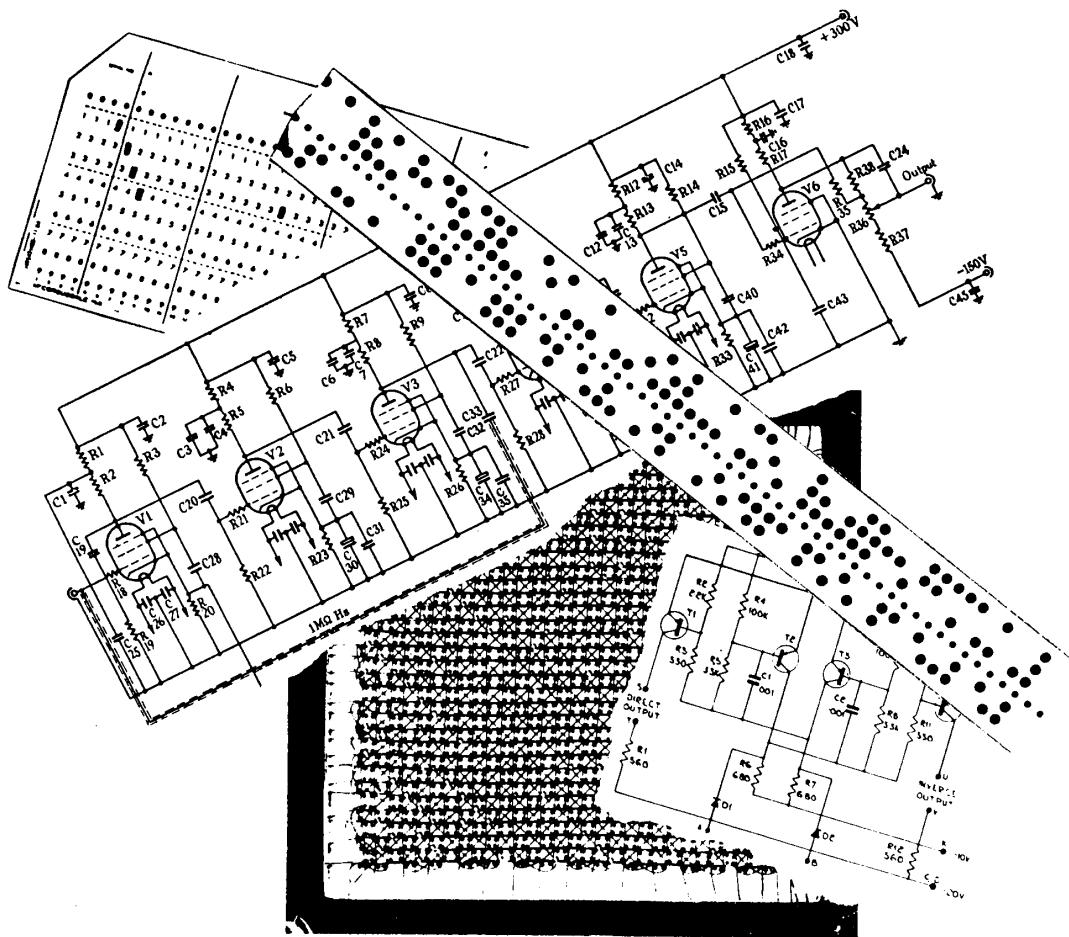
Issue Number 12

Summer 1995

Computer

RESURRECTION

The Bulletin of the Computer Conservation Society



The British
Computer
Society

&

The National Museum of Science & Industry
Science Museum

Computer Conservation Society

Aims and objectives

The Computer Conservation Society (CCS) is a co-operative venture between the British Computer Society and the Science Museum of London.

The CCS was constituted in September 1989 as a Specialist Group of the British Computer Society (BCS). It thus is covered by the Royal Charter and charitable status of the BCS.

The aims of the CCS are to

- o Promote the conservation of historic computers and to identify existing computers which may need to be archived in the future
- o Develop awareness of the importance of historic computers
- o Encourage research on historic computers and their impact on society

Membership is open to anyone interested in computer conservation and the history of computing.

The CCS is funded and supported by a grant from the BCS, fees from corporate membership, donations, and by the free use of Science Museum facilities. Membership is free but some charges may be made for publications and attendance at seminars and conferences.

There are a number of active Working Parties on specific computer restorations and early computer technologies and software. Younger people are especially encouraged to take part in order to achieve skills transfer.

The corporate members who are supporting the Society are Bull HN Information Systems, Digital Equipment, ICL, Unisys and Vaughan Systems.

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Editorial

Nicholas Enticknap, Editor

The early months of 1995 have seen a welcome resumption of the London meetings programme. In the first of the year's events, ICL's long-time research supremo Gordon Scarrott gave members an insight into the thinking behind innovative products such as Cafs and DAP. An edited version of part of this talk can be found starting on page 19.

As the Society's activities in the Manchester area continue to flourish, North West Group chairman Peter Hall has decided the time is appropriate for him to step down. Society chairman Graham Morris singled out Peter's contribution for special mention at the AGM in March; Graham regards the successful establishment of the Group as the most important development within the Society since the last AGM.

Frank Sumner of Manchester University is the person chosen to continue the good work that Peter started. Most readers will be well aware of Frank's standing in the computer community, but nearly everyone should find something of interest in Frank's Guest Editorial, which recalls the heyday of the University's pioneering period.

The Manchester Pegasus Working party has taken research into the dating of the various Pegasus machines a step further, as reported by Ken Turner starting on page 6. Like so much research, it raises as many questions as it answers. Perhaps readers can cast light on some of these new questions, especially any reader who was connected with the Vickers Pegasus systems.

London Working Party activity has remained in a state of suspended animation, as the protracted negotiations about the false flooring in Blythe House grind slowly on, so this section of *Resurrection* is thinner than usual. Pegasus Working Party member Doug Brewster has put his enforced idleness to good use by writing an account of his early experiences of computing as a structural engineer - this can be found starting on page 29.

That other set of protracted negotiations, over the future of Bletchley Park, is beginning to produce some promising results. The joint planning application put forward by the two existing owners of the Park together with the Bletchley Park Trust has now been approved, and it is hoped that work on the building of the Computer Museum can start shortly, as reported by Tony Sale in his regular Society News piece.

Guest Editorial

Frank Sumner

In June 1948 the world's first stored program computer successfully ran a program. At that time I was doing my HSC examinations, and my knowledge of computation aids was restricted to log tables and slide rules. Three years later after completing a chemistry degree at Manchester I started research in molecular orbital theory which entailed large amounts of computation.

After six months of pounding an electric Marchant my supervisor said, "Why don't you go and see Alan Turing? I believe he has some sort of electronic computer." The Chemistry department was about 50 yards from the Mark I computer, which says a lot for the early impact and publicity of computers in Manchester!

Turing was very helpful: he gave me a copy of the programming manual he had written, told me to read it, write a program, and when I was ready to book an hour on the computer and see if the program worked! This was the only "formal" instruction I had, but luckily in those days programming was more a matter of ingenuity than style, and the only concession to structure was the use of sub-routines and ad-routines.

The next 15 years were certainly the most exciting period in my academic career. The Mercury and the Atlas followed the Mark I, and in 1964 the computer group became a separate Department of Computer Science led by Tom Kilburn. In 1965 we admitted undergraduates to the first university computer science course, and from then on teaching and administrating made inevitable inroads into the pleasures of research.

The setting up of the Computer Conservation Society in London and more recently the Northern branch in Manchester has made me very aware of the lack of care the majority of us took in the early days to keep records of what we did and to ensure that design details of hardware and software were preserved. On the positive side however, I have met many people within the Society who were not only successful in preserving material but have shown incredible determination in tracing and recovering hardware and software from the early days of computing in the UK.

In June 1998 it will be the fiftieth anniversary of the running of the first program, and several events are being planned to mark the occasion. The Society is working with the University and ICL to build a

replica, using authentic components, of the 1948 machine. Chris Burton has identified the components required and has miraculously located sources where they are still available.

The City of Manchester is proud of the development of computing within the city, and they will be involved in the anniversary celebrations. A recent indication of the Council's interest in the history of computing was the naming of a section of the new inner ring road as Alan Turing Way, almost certainly the first time a road has been named after a computer scientist.

Internet addresses

Readers of *Resurrection* who wish to contact committee members via electronic mail may do so using the following Internet addresses.

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Society News

Tony Sale, Secretary

The Bletchley Park Trust held a very successful weekend commemorating the 50th anniversary of Victory in Europe. Over 5000 people came to the Park during the weekend of 6-8 May. The parade and drumhead memorial service on Sunday morning were quite spectacular, with over 200 of the wartime codebreakers present to hear an address by Sir Harry Hinsley, wartime head of Naval Intelligence in the Park.

The Society's computer displays were crowded out, as was the Colossus rebuild project which had television coverage on Anglia News on Monday.

All this has greatly helped the Trust's endeavours to acquire the Park, and will support the Trust's application to the Heritage fund for lottery money. The work on the final home for the Computing Museum in D Block may be able to start soon.

Contact point

Readers wishing to contact the Secretary are reminded that he is now running the secretariat from home. The secretarial telephone number is 01234 822788. Letters should be addressed to 15 Northampton Road, Bromham, Beds MK43 8QB.

Determining the Age of the Manchester Pegasus

Ken Turner

In *Resurrection* issue 9 of Spring 1994, Chris Burton identified a relationship between the age of a Ferranti Pegasus computer and the serial numbers of the individual packages which carry the electronic circuitry. It was suggested that this relationship could be used to identify the Pegasus owned by the Manchester Museum of Science and Industry. The North West Group working party has now conducted an analysis of the packages of that machine, but far from settling its identity, the findings raise new questions.

The Manchester Museum records show that its machine is a Pegasus type 1, acquired in 1969 from Brooklands Technical College, Weybridge, having been donated to the College by Vickers Armstrong (Aircraft) Ltd in the mid-sixties. It was originally thought to be the very first Pegasus, machine number 1, but later evidence suggests it is number 6. From an early Ferranti document it is known that the sixth Pegasus delivered went to Vickers Armstrong in May 1957. This company also purchased a Pegasus type 2 in June 1961, and later took delivery of the first machine built, which had originally been installed at Ferranti's Computing Centre at 21 Portland Place, London. The College released its earlier machine on being given a Pegasus type 2 by Vickers Armstrong.

In letters to *Resurrection*, Harry Johnson and Derek Milledge have explained how machine number 1 was modified during its time at the Ferranti Computing Centre and was wrongly taken by its later owners to be a Pegasus type 2. They have also pointed to the fact that machine number 1 should be easy to identify by reason of these modifications. Even if the original machine given to the College was in fact number 1, it is not easy to see how it could subsequently have been confused with number 6 and the 'wrong' machine transferred to the Museum.

Chris Burton's article appeared at the time conservation work started on the Manchester machine. As detailed recording of all inscriptions on the packages formed part of this work, the opportunity was taken to test the theory that this was Pegasus number 6.

The three bay Pegasus contains 24 rows of 20 package positions, all of which are occupied. In addition a tea chest containing 28 spares was received with the machine. Of the total of 508 packages, 29 are blanking

plates which do not carry a serial number, leaving 479 active (ie component carrying) packages to be considered. (Chris agrees that the figure of 597 which he quoted is incorrect and should be 477. However, this number is not relevant to the argument he advanced, which is based on Type 1 packages only.)

As Chris explained, packages are identified by means of a small plate carrying the type and serial number. Such a plate is present on the majority of the packages examined. In a few cases the plate is incomplete, inaccessible or missing, although in the last two cases it is sometimes possible to find the serial number written on the package itself. Altogether, we have records of the serial numbers for 470 of the active packages.

An immediate difference from the machine in The Science Museum, South Kensington is apparent on examining the details on the serial number plates. Whereas the London machine is reported to have serial numbers which are always five digits long, being filled with zeros if necessary to achieve this length, this is not the case with the Manchester packages, where two different types of number are encountered.

Only 115 of the packages have five digit numbers of the type recorded on the London machine. The labels with this format of number are all of one type. In addition to the serial number and two digit package type number they carry a letter *P* separating the two numbers. Typical entries on this group of packages include 01 P 00059 and 06 P 02159.

The serial numbers come from a wider range of package types than those featuring the other kind of label: a number of the packages use printed circuit boards, and some later designs of semiconductor components appear. For these reasons we assume that this series of packages, which I will refer to as *P-series*, are of later manufacture than the remainder. It is tempting to assume that *P* stands for *Production*.

The remaining 355 packages carry serial number plates of several different designs. The type numbers and serial numbers do not have leading zeros and the letters between the two numbers vary, five different letters (*C*, *G*, *L*, *M* and *R*) having been recorded. Over 25% of the serial numbers found consist of a single digit, and only 14 packages use more than two digits. Typical of the legends from the labels of this class of packages are 1 R 1 and 6 C 31.

Many of the labels carry the wording *Ferranti London*. The inclusion of the name *London* appears to indicate that these packages were not made by a

Ferranti factory in the Manchester area - in the sixties Ferranti did not see itself as anything other than a Manchester company. We take these to be the earlier (presumably original) set and they will be referred to as the *E-series*.

In his letter in issue 10, Harry Johnson suggests that packages for machine number 1 were made by subcontractors. It is possible that the letters referred to identify the source. We find that a certain letter is associated with a given package type so that, for instance, type 6 packages in this series all have the letter *C*, type 7 all have *M*, etc. This would presumably be the case if the letters do refer to the manufacturer, since all packages of a certain type would probably be assembled by one subcontractor. Could it be that the letter *R* found on a majority of the type 1 and 2 packages (the most numerous) is associated with Racal?

An exception to the 'rule' linking package types to one letter occurs in the case of the more common package types where a 'minority' letter appears. For example 108 type 1 packages carry an *R* while another nine bear a letter *G*. The letter *G* only appears in small quantities in this way along with some other more common letter.

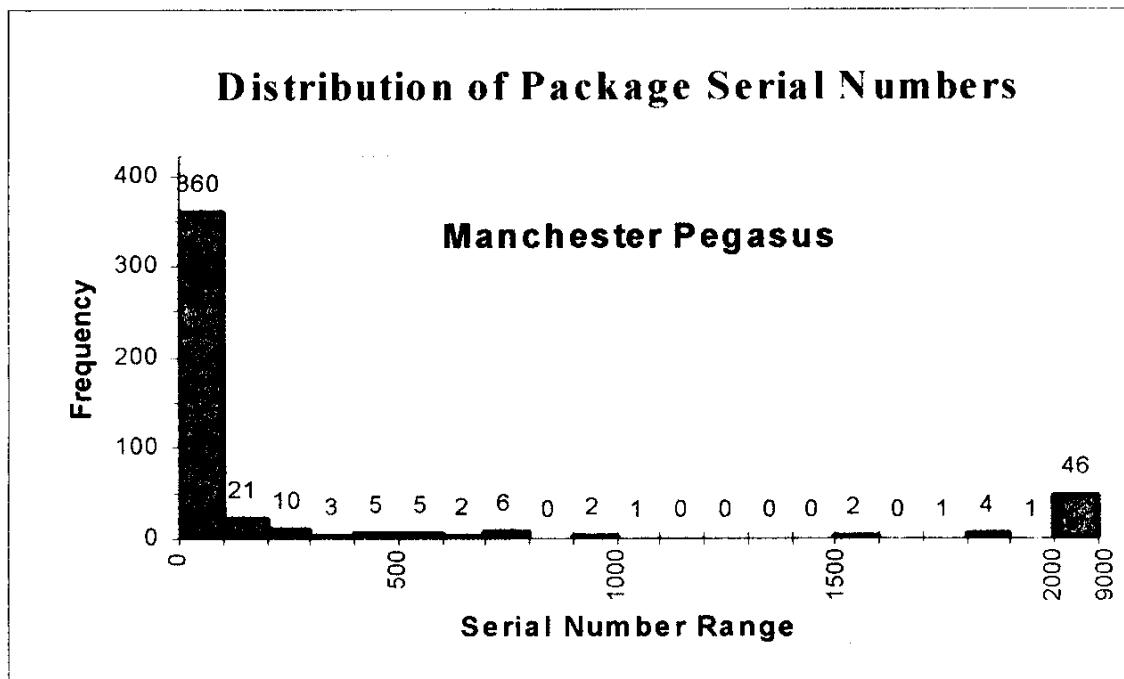
This could be accounted for by the larger numbers of the types of package involved, allowing two sources to be used. As a result we find a duplication of serial numbers within the same package type so that, for example, we have 4C4 and 4G4 - as well as 04P00004! The full serial number including the letter is thus required for identification.

Comparison of numbers of packages and serial numbers is interesting, since it indicates that only one set of E-series packages was made. The highest serial number found for each package type is always within 30% and generally within 10% of the number of packages of that type, suggesting that the quantity of packages made included spares and possibly provision for rejects, but was only sufficient for the first machine.

The evidence seems to indicate that the majority of the packages in the Manchester machine, the E-series, are of different manufacture from the packages used in later machines and constitute the original package set from machine number 1.

The original intention when collecting serial numbers had been to examine the distribution of type 1 packages as proposed in the article by Chris Burton. However, the fact that 101 of the 117 type 1 packages examined are of the E-series and the preponderance of low numbers this causes, makes this unnecessary. An examination of the distribution of serial numbers of all packages of both

E and P series illustrates this clearly. It will be seen that there is a concentration of serial numbers below 100.



It was suggested by Chris that serial numbers might start at 1000. This is not the case with the E-series where the highest number found is 120. Nor is it true of the P-series, 61 of which have numbers less than 1000. As might be expected in the case of a computer, numbering appears to start from zero since we have two P-series packages which are quite clearly numbered 00000. (As observed by Chris in his original analysis, if the origin for the numbers is shifted to 0, it appears more likely that the secondary cluster of type 01s with numbers around 4300 represent the original packages of machine 25. This would support Derek Milledge's suggestion that machine 25 accreted spare packages from scrapped machines.)

The evidence from the cabinets is less clear. Machine number 1 was apparently modified to include a larger drum. The Manchester Museum drum has recently been removed and examined but provides no fresh evidence. The modification would have required the insertion of extra packages in unused positions in bay 2. These packages are not present in the Manchester machine and it is quite clear from the back wiring that the positions have never been used. If drum modifications were carried out to the Portland Place machine then this is certainly not it.

One other piece of evidence may be significant. During the cleaning of the cabinets it was necessary to remove the panel containing the two monitor tubes. Instructions for doing this were obtained from two sources but proved to be inconsistent with the construction of the machine itself. This suggests that the mechanical design of the monitor unit was changed and it would be useful to know at which machine this change was introduced.

In summary:

- o The relation between serial numbers and package quantities suggests the E-series packages were unique to one machine;
- o The design of the package labels and the low serial numbers point to the fact that they must come from the original packages of Pegasus number 1;
- o The timing of the movements of machines to and from Brooklands College imply that the machine must be number 6;
- o Examination of the cabinets themselves shows that this is not number 1.

It appears that at some time there has been a wholesale transfer of packages between machines so that the cabinets of machine number 6 now contain the packages originally installed in number 1. 'Swapping' packages between machines on the same site is a standard way of identifying a fault but there does not seem any reason why the whole complement would be exchanged. Did this perhaps happen at some time by mistake, possibly when the two sets of packages were in storage? The most obvious possibility is that an exchange occurred between 1963 and 1965, when both machines were in the possession of Vickers Armstrong. More precise dates for the various transfers would be helpful.

The North West Group working party would be very pleased to receive any relevant information from members who have associations with either of the machines involved. In particular one name occurs regularly when examining the packages. Most of these have a sticky (literally) label on the handle. This generally identifies the location of the package but a number of them bear the legend *Davidson's Spare*. If 'Davidson' reads this, or if any member can identify him, we would very much like to know!

The Phillips Economic Computer

Doron Swade

Wednesday 22 March was United Nations World Day for Water. This may be an odd fact to tout in a bulletin such as this, but on Water Day a highly unusual piece of computing history went on public display at the Science Museum.

The machine was conceived and designed by Bill Phillips (1914-1975), a New Zealand-born engineer turned economist. The prototype caused something of a stir when first demonstrated at the London School of Economics (LSE) in November 1949. The contraption stood seven feet high and five feet wide and Heath Robinson would have been very pleased. The pumps were switched on and coloured water sloshed around through tanks, pipes, sluices and valves. The levels settled, pulleys turned and a pen plotter traced results. The machine was an hydraulic model of income flow in the national economy. Professors of economics were impressed.

Phillips outlined hydro-mechanical methods of modelling aspects of economic behaviour in a paper written in 1949 while a final year mature student at the LSE. He showed diagrams of economic models to Walter Newlyn, an undergraduate contemporary who had been a year ahead of Phillips at the LSE and had since taken up a lectureship at Leeds.

Newlyn encouraged Phillips to build a machine and was instrumental in securing £100 from Leeds University towards materials for the first prototype. At the LSE, Professor James Meade championed Phillips and his bizarre machine and, as an incentive to Phillips to complete it, promised an opportunity to demonstrate the beast at Professor Robbins' seminar. The demonstration took place on 29 November 1949. The presentation by Phillips and the performance of the machine (built in a garage in Croydon) confounded the sceptics.

Phillips formally described the use of mechanical models to show the behaviour of interacting economic variables in a paper 'Mechanical Models in Economic Dynamics' which appeared in *Economica* in August 1950. The publication of this paper and the impression made by the machine led to his appointment, without interview, as Assistant Lecturer in Economics at the LSE a few months later.

He was awarded his Ph.D ('Dynamic Models in Economics') in 1954, and became LSE's Tooke Professor of Economic Science and Statistics in 1958.

While Phillips is better known to economists for the 'Phillips Curve' which relates wage inflation to unemployment, it is his ingenious and original machine that brings him to the attention of the computing community.

The teaching potential of the Phillips' machine was obvious from the start and about 14 machines are believed to have been built. The prototype went to Leeds University where it still resides as a prized relic of the 1950s. Improved versions went to the universities of Cambridge, Liverpool, Birmingham, Manchester, Melbourne and Harvard, as well as to the New Zealand Institute of Economics. Two machines were built for the LSE.

Not all went to university departments. Ford Motor Company and the Central Bank of Guatemala were customers too. In the USA the machine was called Moniac to suggest money, mania and computation - this last by evoking echoes of Eniac.

The Phillips machine is an hydro-mechanical analogue computer designed to model the effects on total national income of a variety of factors including taxes and government spending, saving and investment, and imports and exports. The movement of money is represented by the flow of water and the accumulation of money (stocks) is represented by water collecting in tanks.

If incoming savings flow exceeds outgoing investment flow, for example, then a balance will accumulate in the Savings and Investment tank and the level will rise. If investment flow exceeds savings flow for any length of time, then the tank runs dry.

The model is a circular one (see diagram). Water is pumped to the top of the machine and cascades down a central column. Taxes, imports and savings are siphoned off into separate loops. Proportions of these rejoin the main flow as government expenditure, exports and investment. The net flow at the bottom of the central column accumulates in a tank. This level represents the working balance required for a given level of economic activity and is duly pumped back to the top of the machine to cascade back down through the system.

The strength of model is in the interactivity of economic factors. Rates of taxation, investment and levels of foreign trade can be altered by setting valves and sluices. More subtly, stocks (represented by the level of water in a tank) control flows elsewhere in the system by automatically altering settings of the valves.

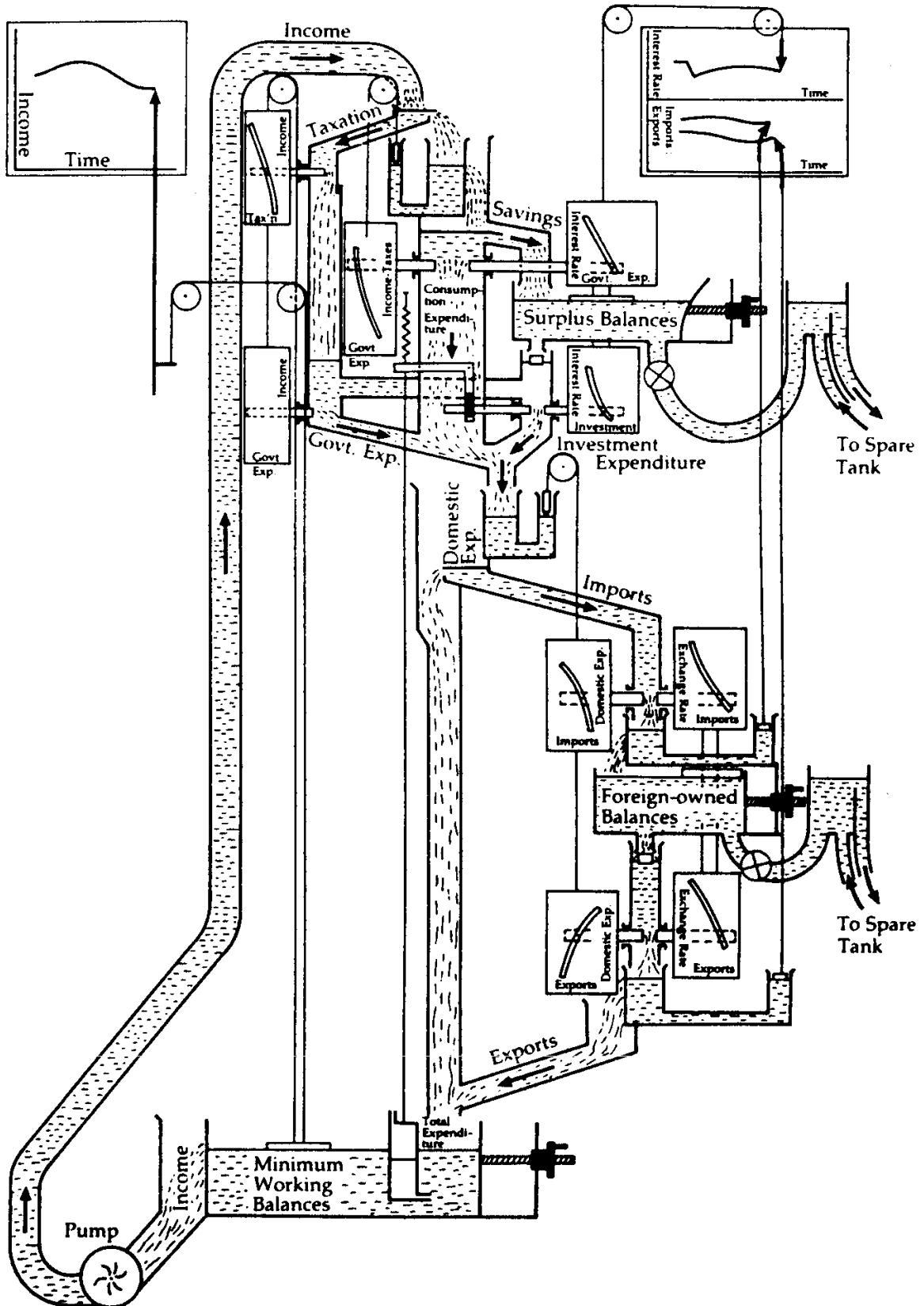


Diagram of the Phillips machine. Source: LSE Quarterly, Winter 1988, Nick Barr.

A further level of sophistication is added by curves cut into Perspex templates to represent the particular form of a relationship between a level in a tank, for example, and a flow. The templates can be altered when the machine is set up and in effect control the transfer functions relating the independent and dependent variables. If the settings represent a viable economy the model stabilises and the quantitative results can be read from scales calibrated to 4%. The dynamic changes between one equilibrium state and another are also correctly modelled and drawn automatically by cord-driven pen plotters.

The Phillips machines were novel teaching aids. James Meade, then Professor of Economics at the LSE, used a Phillips machine to illustrate the destabilising effects of uncoordinated government intervention. One student would act as the Chancellor of the Exchequer with control over taxation and public spending, and a second student as the Governor of the Bank of England with control over monetary policy. Both were given the task of achieving a target level of national income. Crucially, each was instructed to ignore the actions of the other. The results were invariably disastrous.

Phillips machines, for all their ingenuity and appeal, fell into disuse with the advent of electronic computers in the 1950s. Few survive intact, and those that do have deteriorated.

The machine to be displayed at the Science Museum, thought to date from 1952, languished in the basement of the London School of Economics after being retired from active service in the classroom. It was rescued and restored to working order at the LSE in the 1980s and last ran (for a radio interview) in May 1992. The LSE was reluctant to part with the Phillips machine which had become the focus for the affection and respect felt for Phillips by colleagues, students and friends.

Professor Nick Stern, then Chairman of STICERD (Suntory-Toyota International Centre for Economics and Related Disciplines) at the LSE is acutely aware of the significance of the machine as a serious-minded memento of a distinguished episode in LSE's history, and he became properly concerned for its future.

In recent years several factors began to weigh. The small community of those familiar with Phillips and the history of his eponymous machine was dispersing and there was concern that the significance of the machine would fade with successive generations of staff. The two dedicated restorers of the machine in the 1980s, Reza Moghadam and Colin Carter, were pursuing careers elsewhere and

could not provide the continuity of technical support necessary to maintain the increasingly frail device in working order. There was also concern for the gradual deterioration of the machine and the physical consequences of intermittent demonstration. Finally, there was the genuine wish to make the machine more accessible to a wider public.

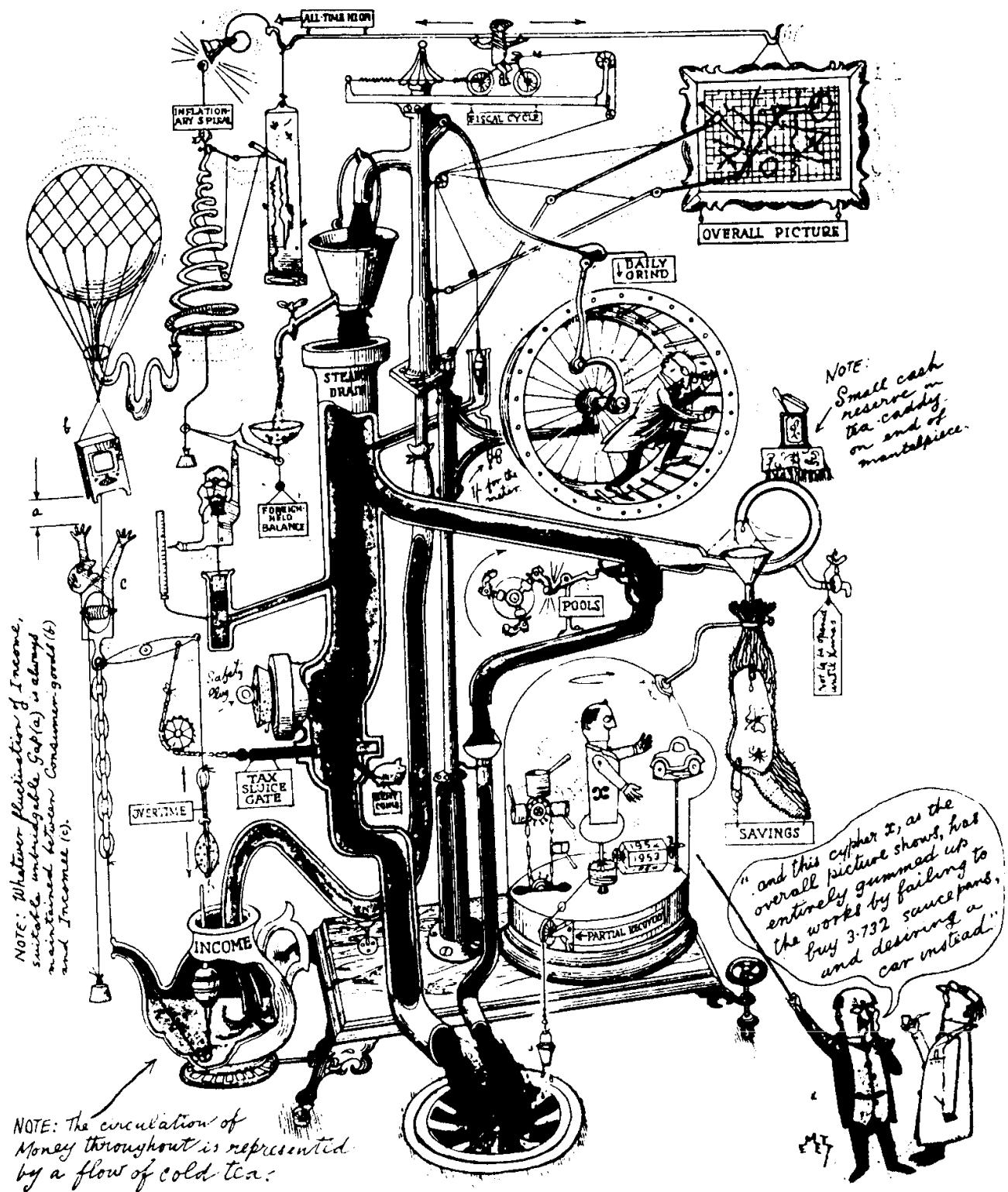
These considerations weighed in favour of transferring the machine to the Science Museum despite the LSE's evident attachment to it. The basis of the transfer was outright donation but with an undertaking, unusual for the Museum, to display the machine, as a condition of acquisition. Expert conservation effort is reserved for fully inventoried objects only, and once acquired the machine was meticulously cleaned and stabilised.

Some 200 hours of conservation work was expended on it. The coloured water was drained and treatments applied. Conservation concerns militate against the machine being run again, and unless a working replica is built, the pleasure, not to mention the educational value of seeing the machine in operation, is a thing of the past.

However, alongside the display case is a video screen showing short clips of the working machine. The programme, which is stored on a one-off glass video disc, uses footage shot for Newsnight purchased from the BBC, newly storyboarded and with new voice-over. The Phillips hydro-mechanical model is an application crying out for software simulation which would have a ready market in university Economics departments.

With electronic computers a daily commonplace it is tempting to see the Phillips machine as an act of pre-electronic desperation - a string and sealing wax solution of heroic ingenuity forced on Phillips by the lack of a digital electronic solution. History confounds this view.

Eniac, the large-scale vacuum tube electronic calculator developed at the Moore School, Pennsylvania, was operational by the end of 1945, well before Phillips' first efforts. Nearer to home was Edsac, the first full-scale electronic stored program computer. Edsac came into service at Cambridge University in June 1949, the selfsame summer that Phillips began work on his prototype. Phillips was part of an academic community and it is inconceivable, given his interests and talents, that he was unaware of these developments.



Phillips' machine provided inspiration for this Emett cartoon, which appeared in Punch 15 April 1953.

In the early 1950s Phillips used an electronic analogue computer for macroeconomic modelling at the National Physical Laboratory where Richard Tizard was head of the Automatic Control Group. Later in the 1950s Tizard and Phillips used an English Electric Deuce, a digital vacuum tube machine, located at Aldwych, for joint economics research.

The new electronic computers were quite up to the computational task of economic modelling. The problem for Phillips was not computer processing power but visual display. Punched paper tape or numerical results tabulated offline by teleprinters are hardly distinguished for their visual immediacy. Without electronic VDUs the behaviour of arcane mathematical models was invisible and the process quite hidden.

Phillips wrote in 1950 that available electronic systems may well have offered greater accuracy and flexibility. But since his apparatus was intended for 'exposition rather than accurate calculation', it was desirable that the interactions were 'immediately comprehensible to the viewer'. So Phillips' choice of plumbing and Perspex was conscious and deliberate, and the visual immediacy of his hydro-mechanical creation vindicates his stand.

Economic theory has moved on and Phillips' theoretical model, though still relevant, is no longer complete. The machine now stands as a monument to an inspired piece of pedagogy. But the machine is symbolic in another respect. It suggests that economic behaviour can be described by mechanistic models and that economic modelling might submit to control theory.

We have been spoiled by science and engineering. We expect from economists the same degree of certainty offered by physicists and engineers. Despite the sophistication of economic theory it is not nearly as effective in predicting economic events as is control theory, for example, in predicting the behaviour of physical systems. Uncontrollable decline, an obstinate recession, and currency crises are not the best advertisements.

Economists now embrace chaos theory and increasingly use statistical models, and this tends to obscure the failure of mechanistic determinism. But perhaps we are wrong to see the Phillips' machine as a symbol of predictive certainty. When operated, the machines were sometimes temperamental and prone to spring leaks. Phillips was repeatedly called away to a repair an incontinent machine which had disgraced itself during a class. It may be that the machine, like the economy, is

defying our efforts at control, by flaunting the irregularity of its ways, and giving us a cold shower in the process.

Doron Swade is Senior Curator of Computing and Information Technology at the Science Museum in London.

Editor's note: an edited version of this article has appeared in The Guardian, 16 March 1995, under the title 'Liquid assets'.

Pegasus simulator

Members of the Society who have early versions of the Pegasus simulator PEGEM may be interested to know that the latest version has been much refined, with improved graphics and an online manual for operation of the simulator. If you would like a copy, please send four 25p stamps to cover the cost of the diskette and postage to Chris Burton (for address see inside back cover). The simulator runs on any industry-standard PC with VGA graphics and a hard disc, and is supplied on 3.5" diskette unless 5.25" is requested. In the latter case, please state whether 360Kb or 1.2Mb format.

From Torsional Mode Delay Lines to DAP

Gordon G Scarrott

This article describes the origin and development of five research projects managed by the author during his career at first Ferranti, then ICT and finally ICL. He also gives his verdict on the success or otherwise of each of the projects.

I will start with torsional mode acoustic delay lines. These were developed in the Ferranti Computer Department long before it was incorporated in ICT. To explain how the project started I will need to go back in time to the period before I came into the computer business.

I worked at the Cavendish Laboratory at Cambridge from 1946 to 1953, developing instruments for nuclear physicists. Towards the end of that period I was heavily engaged jointly with GW Hutchinson in the development of an instrument known as a pulse height analyser (or colloquially as a kicksorter). It incorporated 60 binary registers each with a capacity of 20 bits, implemented as an acoustic delay line store.

The first version incorporated an elegant folded mercury delay line. After building it we heard about the wire type acoustic delay lines being developed in the Elliott laboratories at Borehamwood, so in our second instrument we incorporated a nickel wire type delay line - it had obvious advantages over the mercury delay line.

About that time Brian Pollard, who was then the manager of the Ferranti computer department at Moston in Manchester, offered me a job with the title Chief Research Engineer at Moston, probably because of the relationship between computer technology and the techniques that I had been developing for nuclear physics instrumentation.

I was to spend the rest of my working life in the computer business, but when I joined Ferranti in 1953 I had no idea what computers did or how they worked. So I cannot claim to have entered the computer business deliberately: the computer business recruited me.

When I arrived at Ferranti I found that the engineers were familiar with the cathode ray tube storage technique developed at Manchester University, but had no experience with acoustic delay line storage. So it was obvious that my first research project should be to study wire type delay line storage techniques and endeavour to maximise their storage capacity.

We very soon discovered that the limit to the storage capacity of wire type acoustic delay lines was set by dispersion of the longer wave components of the acoustic signal on account of the curvature of the wire. To achieve adequate time delay it was necessary to use several metres of wire and for obvious practical reasons it was necessary to coil the wire to fit it into a practicable package.

In the course of a chance discussion regarding the delay line project with John Bennet (whom I had first met at Cambridge and who joined Ferranti at about the same time I did), I mentioned that the limit to the achievable storage capacity was determined by dispersion arising from the curvature of the wire. He made the interesting suggestion that since torsional waves travel more slowly than longitudinal waves it might be possible to make better delay line stores by the use of torsional waves, a possibility that had not occurred to me.

We therefore undertook a theoretical analysis of the properties of torsional waves in a curved wire, and discovered that torsional waves offered even more advantages than we had at first realised. Not only is the velocity of torsional waves only 0.6 of the velocity of longitudinal waves, but the dispersion is proportional to the product of two curvatures - the natural curvature of the wire and its curvature forced within the elastic limit by the wire mounts.

Hence if the wire can be made naturally straight, that is with zero curvature, and mounted so that its forced curvature is within the elastic limit for the wire material, the dispersion effect disappears.

However, this happy discovery raised two questions: how to generate and how to detect torsional waves? It occurred to me that it ought to be possible to make an acoustic impedance matched mode converter, so that the waves are generated and detected as longitudinal mode while most of the delay arises in the torsional mode.

We derived the geometrical conditions to achieve the desired acoustic impedance match and I personally made the first such mode converter by the use of a small spot welding machine in the Moston factory. To my considerable surprise and delight the mode converter worked perfectly the first time. In due course torsional mode delay lines became widely used, not only in Ferranti equipment but by the world and his dog, notably to provide the storage for visual display units.

Eventually delay line stores were displaced by semiconductor stores taking advantage of silicon planar manufacturing techniques, but torsional delay line

stores lasted long enough in the market place for the project to be counted a success.

The second project I would like to discuss is Ballot Box Logic. Before transistors became available it was obvious that logical technology based on the use of large numbers of vacuum tubes to provide the necessary amplification would be expensive and untrustworthy. We therefore endeavoured to devise other ways of achieving enough power amplification to achieve a useable fan-out without the need to include a vacuum tube in every logical device. In principle this can be done by the use of a magnetic amplifier based on a combination of a saturable magnetic core and a diode with energy supplied by a regular powerful shift pulse.

To use the magnetic amplifier we found it necessary to invert the conventional electrical impedance properties of established electronic logical techniques. In established practice a typical logical device has a high input impedance and a low output impedance, so that to a first approximation the output is a well defined voltage signal and the input presents a high impedance. As a result, several inputs can be driven in parallel to achieve the required fan-out.

To make useful general purpose logical devices based on a magnetic amplifier, we found it necessary to make its input impedance low and its output impedance high so that the output signal approximated to a defined current source. When several inputs were required to be driven they were connected in series instead of the conventional parallel.

With these conventions it was possible for a single design of magnetic amplifier to offer the usual range of logical functions - and, or, inhibit, and even any two out of three, a useful function for generating the carry signal in a binary adder. The various logical functions were achieved essentially by linearly adding the input signals and generating an output signal if the sum exceeded a fixed threshold, defined by the saturation property of the magnetic core. This process came to be known as Ballot Box Logic by analogy with political voting procedures.

We made a few magnetic core logical devices following these principles, which worked as expected, but since the energy supply came from the shift pulses the generation of such pulses was not easy. At about that time transistors started to become available at a reasonable cost, and offered a power amplifying technique with obvious advantages over the magnetic amplifier that we were studying.

This situation was observed by KC Johnson who proposed a logical element (the Neuron) with the same impedance conventions as the magnetic device

but with the power amplification provided by a single transistor. We made a few of these and they worked splendidly, first in a test assembly known as Newt (for neuron test bed) and then in a small computer known as Sirius that also incorporated torsional mode acoustic delay line storage. So we abandoned work on the magnetic core devices and concentrated our efforts on the development of the neuron technique which seemed to offer several advantages.

It was a package technology with only one package type that provided all the required logical functions, with obvious advantages in manufacture. It required fewer transistors than more familiar logical systems. We considered this to be a significant advantage because at that time transistors were still quite expensive and made by techniques that did not inspire confidence. The logical designers after their experience with Sirius were confident that they could implement any system concept required to meet market requirements for a computer intended to handle business information.

At that time there was clearly visible a requirement for such a computer (eventually to become Orion) to handle business information on a time sharing basis. The logical design team, taking perhaps overfull advantage of the clean interface between logical design and electronic design offered by the ballot box logic/neuron technique, conceived an elegant technique for ensuring that a fault in one of the programs could not sabotage any of the other programs.

This was a valuable innovation - Orion was the first trustworthy time sharing system to be demonstrated in the information engineering field. Moreover the system technique pioneered in Orion was incorporated in a system devised by an American branch of Ferranti and known as the FP6000. This eventually became the 1900 series of systems that served ICT and ICL profitably for many years, notably by offering a working time sharing system to users while IBM was still trying to work out how to implement such a system.

Unfortunately the clean interface between logical and electronic design offered by the neuron technology and ballot box logic turned out to be an illusion. The logical designers conceived an elegant system that had long term value, but its implementation using neurons turned out to be too great an extrapolation from Sirius.

It was discovered painfully that the Orion logical system did not work electronically, mainly because Orion was physically much larger than Sirius

with consequential longer interconnections. There is no doubt that this error of judgement, for which I must accept responsibility, was largely responsible for the commercial need to incorporate the Ferranti computer department in ICT.

Ballot box logic thus turned out to be a commercial disaster. With the benefit of hindsight we can recognise that it occurred because when neurons were conceived transistors were still costly and made by techniques that did not inspire confidence, so a reasonable objective of electronic design was to minimise the use of transistors.

But we failed to foresee the development of manufacturing techniques, notably planar fabrication, by which transistors would become far less costly and more reliable. In present day practice the most reliable components are the transistors and the least trustworthy are the interconnections, a situation far removed from the situation in the early days of computers. Project number three on my list is Cafs. In 1962 there was a wave of published papers on "Associative Stores", which were semiconductor stores with an additional access mechanism for access by automated search. It occurred to me that if there was indeed a requirement for store access by search and the storage device under consideration rotated for fundamental reasons derived from the physical storage mechanism, then by a simple low cost addition it would be possible to achieve access by search with average access time half a revolution, exactly the same as access time to a known address. Thus associative access would be achieved at no cost in access time.

I therefore wrote a memo to Peter Hall, the manager of the Ferranti computer department, pointing out this potentially valuable possibility. He, quite properly, passed on this suggestion to systems and software experts in the department.

They rejected my suggestion on the grounds that there was no need for store access by search since an essential starting point for any program is a storage map, in effect a filing system, that recorded what was stored where. They rejected the suspicion that perhaps sometimes the conception and use of such a map might be so difficult that an autonomous store searching subsystem might be more cost-effective.

In effect the Ferranti systems and software priesthood rejected my suggestion on the grounds that they believed that it was possible to devise a perfect

filing system that could always point to the address of a desired item of information.

Anyone with experience of real life knows that there is no such thing as a perfect filing system. Sometimes one finds it necessary to access files by search. In the early days of information engineering, though, the intrinsic disorder of human affairs and the information that controls them was not recognised by system and software designers. That in my view was the fundamental reason why my first suggestion that there was a requirement for file access by autonomous search was ignored.

However in 1962 the Ferranti computer department became part of ICT. One of the consequences was that I suddenly found myself in charge of a team formed by combining the ICT and Ferranti groups.

Shortly after the Ferranti/ICT merger I was approached by George Coulouris of Imperial College who wanted to undertake a field study of what users did with information, and then propose ways of meeting their requirements at minimum cost. I rapidly warmed to Coulouris's proposal, since his starting point and decision sequence followed closely my own view of the proper way to steer industrial research. I therefore accepted his proposal and asked Roy Mitchell to cooperate with Coulouris on a project which became known as Cafs (Content Addressable File Store).

Coulouris' field studies quickly revealed that there was a requirement for a backing store with a facility for access by search. Mitchell, who was familiar with my memo to Peter Hall, sketched a logical design for achieving it with a disc store, so that the disc store could still be used in the conventional way by accessing a defined address, but could also access the store by comparing information read from the store with information placed in key registers, so that when a coincidence occurred the associated information was made available.

We built a pilot version of Cafs and quite quickly demonstrated that it worked as intended. It was cost-effective, and it offered a solution to real user problems. We were able to check this aspect of our work by deliberately cultivating a good working relationship with salesmen who sometimes brought customers to see the research team at Stevenage. They confirmed that Cafs fulfilled a function that was potentially of value in their operations.

Armed with such confirmation, our next objective was to persuade the company product planners that Cafs subsystems should be included in the ICT product line. This turned out to be a formidable task: we did not succeed

till 1981, shortly after I had attained retirement age and a new managing director had been appointed: of course these events were not related!

Recently by chance I met a leading member of the present product planning organisation who told me that Cafs is now an important feature of the ICL product range, and that arrangements are now in hand by which IBM systems will include Cafs subsystems. This item of news that gave me some personal pleasure - I recall early attempts to get Cafs accepted in the company product line when I was told that Cafs could not be right because it was not in the IBM catalogue!

I have no hesitation in claiming that Cafs was a successful initiative by the ICL research team and that all concerned have much to be proud of, notably Vic Maller who maintained the momentum of the project over several years of frustrating opposition from the product planning establishment.

Next, the Basic Language Project. When I joined the Ferranti computer department I became uneasily aware that we seldom saw the systems and software engineers and had only a hazy idea what they did. They knew that we electronic engineers did not understand systems engineering, and tended to refer to us almost with contempt as "Hardware men". This was a situation that I did not relish, since I could not accept that it could be possible to undertake research in information engineering without an understanding of the whole scene.

I endeavoured without success to formulate an understanding of the train of reasons that had caused the main features of a typical computer to be designed. It slowly dawned on me that the design of computers had no foundations in science as I had been taught to expect.

Some of my difficulties arose from the fact that computer systems had been shaped by pure artistry (instant invention), so that interpreting the design process was like trying to understand a painting by Jackson Pollock. This view of established system design practice was supported by the observation that schools of system design existed whose products had a distinct style, and sometimes regarded the works of other schools with thinly disguised contempt.

Eventually I met John Iliffe in the Ferranti team, a creative and determined system designer whose reasoning I could understand since he published his analysis in a book, "Basic Machine Principles", published by Macdonald

in 1968. He recognised that a computer program, like natural language text, is created by a recursively defined process. This is a consequence of the natural way we handle information: we consider arbitrarily complex matters by dividing them into manageable sections to avoid the need to consider a complex matter all at once.

It follows that many of the hazards of program development arise when one program (A) initiates another program (B): then an important objective is to ensure that a program fault in A cannot sabotage B and vice versa. Iliffe proposed how this could be achieved by providing means by which the organised structure of the information in the computer could be explicitly represented and used to prevent the propagation of program faults.

To control the operations of his intrinsically secure computer he devised a control language, The Basic Language, so that he referred to his proposal as The Basic Language Project. Iliffe's proposal was the first system design that I was aware of that was based on sound analytical reasoning.

So we embarked on a project to build a basic machine and demonstrate that programming it to tackle real problems was indeed less hazardous than for conventional machines. (At about the same time other systems engineers embarked on related projects such as the Capability System at Cambridge.)

Our basic language project successfully demonstrated the validity of the analysis underlying Iliffe's proposals. The next problem, as for Cafs, was to persuade the product planners to incorporate the basic language techniques in ICL system products. After protracted discussions we failed to convince the product planners of the need to ensure interprogram protection as well as intraprogram protection, so there is no reason to expect present ICL systems not to suffer from the software crisis that has afflicted the software development process for computers of many manufacturers!

This failure has had damaging consequences for the prosperity of ICL, so an analysis of its causes is of interest.

First, at about the same time that we embarked on the basic language project, Manchester University embarked on MU5, declaring as the starting point that for a time sharing system it was essential to ensure that a fault in one program could not sabotage another program controlled by the operating system, but that no other interprogram protection was necessary or practicable. This declaration was essentially the same as the assumption made by the designers of Orion many years ago, so it was quite out of date.

Unfortunately the ICL establishment system designers adopted the same design objectives as the MU5 designers, and also the same store management techniques, which made interprogram protection impossible. They could not be persuaded to change their views, doubtless on account of the long history of collaboration between Manchester University and Ferranti designers.

Second, John Iliffe always referred to his proposal as the basic language machine, and this was entirely justified as a way to draw attention to its fundamental significance. However the arguments implied by the title "Basic Language" were too subtle to be understood and did not emphasise the essential physical innovation - the explicit representation of data and process structure. Perhaps if we had recognised earlier the need to emphasise this we might have succeeded.

Third, in the activities of ICL Research we were quite properly allowed total freedom to pursue developments that I believed were potentially relevant to the future prosperity of ICL. However this meant that the only occasions when I had any liaison at board level were when I wanted to sell them something, so I had no opportunity to build the ordinary human relations of trust that arise from day to day cooperation. Perhaps it was this background situation that made a difficult communication problem impossible.

Fourth, it is now widely recognised that the process of developing software for real applications is an unmanageable shambles that too often leads to costly failure (for example see the article in *Scientific American* September 1994). Iliffe forecast this situation many years ago, diagnosed its causes and proposed practicable techniques for solving the problem.

The software crisis that was only a threat when we were trying to insert Iliffe's techniques into ICL products is now clearly visible, and Iliffe's techniques for tackling the problem are still valid. Perhaps they should be reconsidered by commercial managers in the information engineering industry as the only credible way to bring the process of program development under manageable control. My fifth and final project is the Distributed Array Processor, or DAP. In 1967 ICT and English Electric Computer division merged. Consequently the Research department of ICT was suddenly enlarged by the English Electric research team, and I had to review the projects they had in hand. One of the team was Stuart Reddaway, a bold innovator, who proposed a new enterprise, which was to build the DAP.

His presentation started from a clear statement that there was a requirement for a cost-effective technique to tackle large physical field problems (of which weather forecasting is a familiar example).

He therefore proposed a two dimensional array of simple processors, each handling one bit operands and obeying a program common to all the processors, but with a vestigial degree of local autonomy provided by the use of an "activity bit". This, when set in any one processor, caused the next instruction to be ignored by that processor. Each processor was to be equipped with its own store.

Reddaway's system design was indeed well adapted to large physical field problems, which are characterised by the fact that the same laws of physics apply everywhere in the field of the problem but there are boundary conditions that must be taken into account. Hence the control technique proposed can usefully be described as management by exception.

I had little hesitation in agreeing to support his DAP proposal, and in due course we obtained Government ACTP (Advanced Computer Technology Project) support for the development. Reddaway and his team built the first DAP and it performed as expected.

However, the market for such a bold innovation was quite distinct from the market for traditional ICL products, so ICL management decided to leave the commercial exploitation of the DAP to other organisations. Consequently the team that originated the DAP still exists but is now a part of an American company, Cambridge Parallel Systems.

I am not clear whether we should regard the DAP as a success. In ICL affairs it is probably a failure since it cannot be claimed that the DAP has contributed to the prosperity of ICL, but the principle of massive parallelism pioneered by the DAP has been widely imitated so that the whole story has not yet emerged.

Editor's note: this is an edited version of part of the talk given by the author to the Society at Birkbeck College, London on 22 March 1995.

Early Computer Use by Structural Engineers

Doug Brewster

I was first made aware of the potential of electronic computers by an article published in the *Structural Engineer* in January 1956, written by RK Livesley of Cambridge. I also recall an article by JW Bray discussing analogue devices being published in the same journal in August 1957.

These papers illustrated the way in which the Theory of Elasticity could be represented in programs providing practical solutions to real engineering problems. It was some time, however, before structural engineering computer applications packages became available.

If we concentrate on activities in the UK (while not forgetting the considerable strides made at the same time in the USA), Elliotts was among the first to provide computing facilities specifically for structural engineers.

Elliotts proceeded by studying the range of problems that arose in day to day activity, developing the necessary programs in close consultation with the engineers involved, and then presenting the results in an appropriate form.

This fairly quickly led to the creation of Elliotts Computer Workshop, a package based on the Elliott 803 computer and installed in the offices of several consulting engineers. Those engineers had use of the machines throughout the normal working day, while in the evenings and at weekends the facilities were made available to other engineers.

Elliotts produced a series of programs in autocode. The use of this language allowed modifications and the addition of new routines to suit individual engineers. The programs included LC3, LC7 and LC8 for continuous beams, plane frames and plane grids respectively. I used a version of modified LC7 known as LC7B and developed by JS Roper of Durham University.

At the same time Loughborough College at Finsbury had a Pegasus which they also made available for outside use. I found it possible with the help and encouragement of the staff running the Pegasus to develop solutions to a range of engineering problems using Ferranti autocode.

It was at this stage that I realised the full force of the obstinacy of electronic computers, a characteristic which I do not feel has diminished despite all the subsequent improvements in languages and hardware.

The situation today, where quite extraordinary analyses are being performed using desktop systems, exists to some extent because of the activity in these early days, which helped to mould a collaboration between on the one hand the engineers and on the other those who were developing the computers.

It eventually became possible to increase the scope of computer applications by using them to plot planeframe outlines, deflected shapes, bending moments and shearforce diagrams. This was done by feeding 5-hole paper tape output from the L7B program run on the 803 into a Zuse computer, equipped with a plotting table with four alternate pens to present colours or a range of line thicknesses.

The Institution of Structural Engineers was making its own efforts to provide its members with a knowledge of the benefits of computing power. There were two main activities. The first was liaison with the Government over its vague promises of the advantages of "white hot" technology. The second was the preparation of an index of computer routines and complete programs. A number of committees was set up to coordinate developments.

For example, work was being carried out on bridge deck analysis on the Loughborough College Pegasus, continuing an earlier study by the Concrete Society at Wexham Springs. A detailed description was published in the *Structural Engineer* in November 1961, and that attracted attention as far away as Bratislava, where it turned out virtually identical results were being produced on an Elliott 803.

Computer bureaux were now beginning to appear, offering a wider range of programs on various improved machines, and supporting them with more advanced languages such as Fortran, Algol and Cobol. One important program at this time was Stress, which subsequently became associated with the widely used package Ices (Integrated Civil Engineering System) developed by the Massachusetts Institute of Technology (MIT).

Ferranti was one of the companies offering a bureau service, using principally Sirius and Orion computers. Engineer users of this service were still working principally in autocode. But a Ferranti advance was the offer of engineering backup - running programs overnight and providing the results first thing the following day.

As time progressed it became possible, given the availability of paper tape or card punching equipment, to develop engineering programs using Fortran or a similar language and to obtain results from a bureau at almost any time

of day or night. Apart from Ferranti's Newman Street bureau, companies offering such services included IBM (with bureaux in Newman Street and Wigmore Street), Leo Computers (Kensington) and Computime (Oxford Circus).

Software companies specialising in engineering problems also started to appear. Among the earlier companies were Engineering Computations in Newman Street, Engineering Solutions and Engineering Analysis (both based in Croydon), Taywood in Hanger Lane and Electronic Calculus in Marylebone.

American applications also started becoming available, such as Ices. Engineers had to take care with these products, however, when these products reflected detailed engineering practices rather than mathematical principles, as US practice was significantly different from that in the UK and Europe.

Indeed, the Government decided it should take the lead in promoting the development of a system suitable for the UK. Following a review of existing systems, it appointed Alcock Shearing and Partners to develop a system to be known as Genesys (for General Engineering System).

Meanwhile bureaux started running machines of greatly improved speed and memory, such as the CDC 6600, Univac 1108, Ferranti Atlas and IBM 360. These could run Fortan and Algol programs and also a range of more elaborate engineering software.

A group of Consulting Engineers now formed a company known as Computer Consortium Services specifically to develop programs for structural engineers. These were available not only to members of the group, but also to any other user on a fee-paying basis.

Many of these programs are still in use today, after many years of debugging, modification and enhancement. They include Leap (Linear Elastic Analysis Program), Deap (Dynamic ditto), Hinge (Plane frame with automatic hinge formation) RC Beam and RC Column (Reinforced Concrete beam/column design, detail, reinforcement schedule and quantities), and Barshed (Concrete reinforcement workshop scheduling).

Today, of course, engineers use desktop devices which match or exceed the power of the supercomputers of the sixties. Many of the ambitious ideas of the early days, which were much too elaborate for the equipment of the time, have now been realised on desktop machines.

During the early days of desktop PCs, it was possible to find listings in Fortran or Basic in various publications of solutions to several standard engineering and mathematical problems. It is a pity that this period had to end. Now only

professionally produced and quality assured software is acceptable, because of insurance and other requirements.

I feel that too much effort went into the development of grand and majestic software in those early days. In contrast, too little attention was paid to automating everyday design office activity, involving relatively straightforward calculations of member sizes and connections.

Today, the choice of structural members can be more fully assessed on an economical basis by the use of iterative methods, which makes more efficient use of the engineer's time and of construction materials, and leads to fewer errors in design calculations.

Doug Brewster is a member of the Society's London Pegasus Working Party.

Historic Computer Music

Chris Burton

North West Group member Frank Cooper recently donated an old 78rpm acetate gramophone record to the Society. It is a recording cut by the BBC on 7 September 1951 of the first Ferranti Mark I computer, which had then recently been installed at Manchester University. Frank explains that Christopher Strachey had written a music program, which greatly astonished the engineers and users when they first heard it. The Children's Hour team took a recording van to Manchester and recorded the feat, and Frank persuaded the engineer and producer to cut a recording for him on "a scrap disc". There are about four bands of sound, each of around half a minute in length.

I took Frank's disc to the National Sound Archive, together with a 10 minute recording of Frank's reminiscences about the disc. The NSA has now copied the material in archival analogue and digital form, and the public can visit the archive and hear the result. The Computer Conservation Society has a second copy on cassette tape as well. The NSA people have since told me that they have tried to trace the Children's Hour version, but it appears to have been scrapped. If so, then it is possible that our disc is the world's first recording of computer music. Many thanks, Frank, for looking after the disc and for donating it to the Society.

Letters to the Editor

Dear Mr Enticknap,

The Zebra simulator referred to on page 15 of issue 11 was finished just before Christmas, and contains the LOT issue 4 together with several sample programs. If any reader would like a copy, which includes the Pascal source code, they should write to me enclosing a 3.5 or 5.25 inch disc.

Dr van der Poel keeps sending improvements to it, and has also drawn my attention to some errors in my article in issue 11. The main ones concern the acronym, which was coined by his wife and is spelt "Zeer Eenvoudige Binaire Reken Automaat"; the name of the author of Simple Code is van der Mey - he is now 81 and still going strong; and the efficiency meter reading for Simple Code, which ran at 70% rather than 50%.

The Society is planning an afternoon meeting on the Zebra on 12 October 1995. This will provide an opportunity for *Resurrection* readers to talk about their experiences of the machine!

Yours sincerely,

Don Hunter
Elmdon
Essex
21 February 1995

Editorial fax number
Readers wishing to contact the Editor may now do so by fax, on 0181-715 0484.

Working Party Reports

Elliott 401

Chris Burton, Chairman

The Working Party is effectively suspended until working conditions at Blythe House are satisfactory. There have been problems with making progress with the false floor and services necessary for the restoration of the system. We understand that these problems are being addressed, and we expect to resume meetings when they are solved.

North West Group Pegasus

Charlie Portman, Chairman

Work on the Processor bay is now complete. The drum has been cleaned, and the heads 'stood back' to prevent further damage to them and the surface (which is already damaged).

The power bay is now more than half complete. The heater 'run up/down' gearbox has leaked quite a lot of oil and is currently being investigated.

This conservation phase will soon be complete. Further activity will depend on the museum's decision on its new gallery and the state its exhibits will need to be in.

Science Museum Pegasus

Chris Burton, acting Chairman

The new room has now been built around Pegasus, and a Working Party meeting was held in January to sort out the spares, documents and ancillary equipment. Pegasus itself had been covered in polythene sheeting; we removed it and cleaned up the machine. As usual, several fuses blew at switch-on, and the backwiring was tweaked to clear deteriorated insulation.

Unfortunately, the machine did not work, with symptoms reminiscent of the corrupted clock track on the drum experienced in 1993. There was no time to fix the problem, nor was there in a subsequent short visit to the machine in March.

Meanwhile, the room has regrettably been used as a temporary store for computer equipment. Another all-day meeting of the Working Party will be called when the room is cleared again.

North West Group

The North West Group would particularly welcome any material - data, manuals, film - on the Ferranti Sirius and Metrovick 950 computers. Anyone who can help here or who would like to play any part in the group's activities should contact secretary William Gunn at 23 Chatsworth Road, High Lane, Stockport, Cheshire SK6 8DA: tel 01663 764997.

Forthcoming Events

3-4 June 1995, and fortnightly thereafter Guided tours and exhibition at Bletchley Park, price £2.00

Exhibition of wartime code-breaking equipment and procedures, plus 90 minute tours of the wartime buildings.

2-3 September 1995 Bletchley Park V-J Day anniversary commemorations

12 October 1995 Half day seminar

The Zebra computer

17 October 1995 North West Group meeting

J Howlett and A Bagshaw will speak on "Getting Atlas off the ground".

28 November 1995 North West Group meeting

L Griffiths will speak on "Computing at Rolls Royce".

The North West Group meetings will be held in the Conference Room at the Museum of Science and Industry, Manchester, at 1730. Refreshments are available from 1700. Members will be notified of the time and location of the Zebra seminar in due course.

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