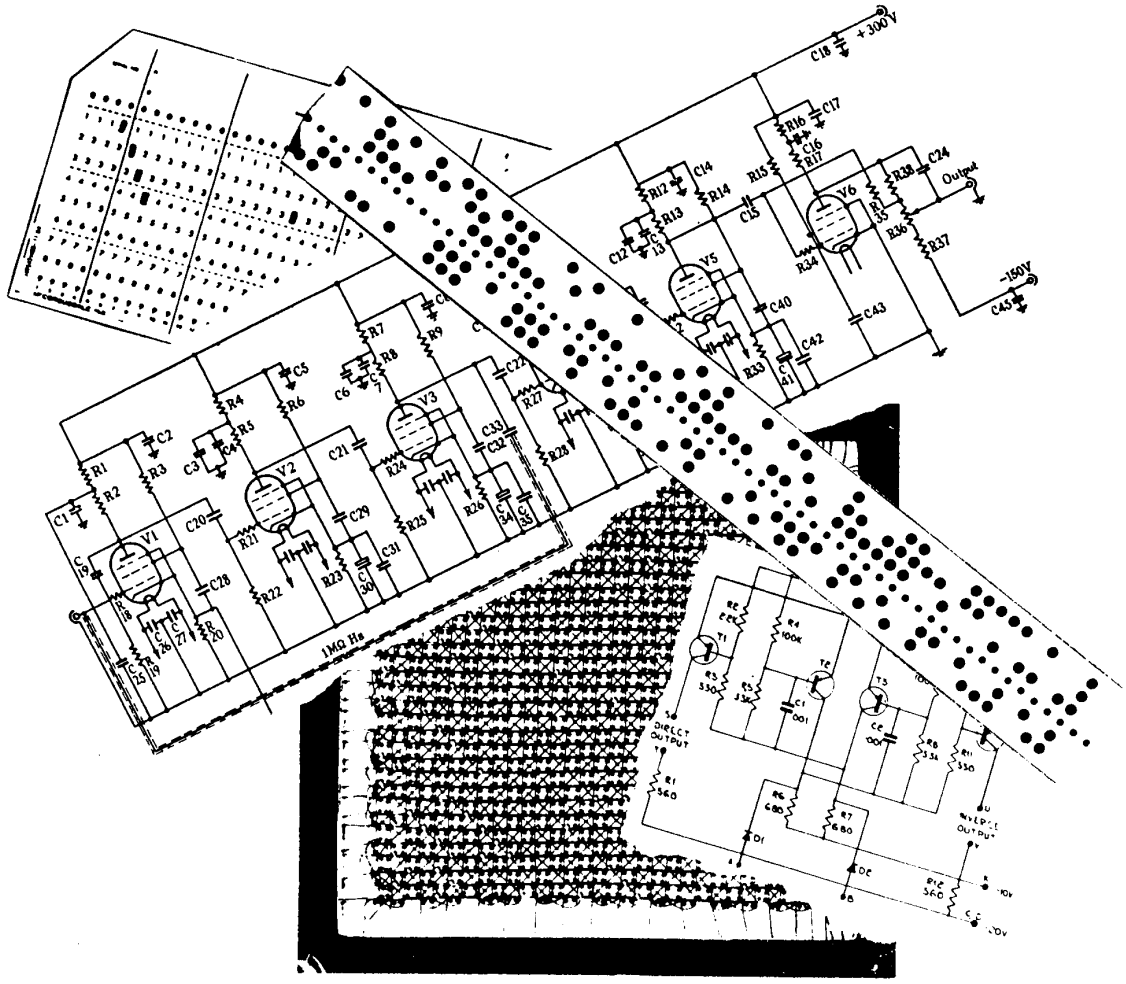
Volume 1 Number 1 May 1990

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

- Promote the conservation of historic computers
- Develop awareness of the importance of historic computers
- Encourage research on historic computers

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.

Resurrection

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ISSN 0958 - 7403

Volume 1 Number 1

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Comment

Ewart Willey, Chairman

A most gratifying start

It is a privilege and a pleasure to write the editorial for the first issue of Resurrection. The title is not an acronym, but, we hope, an evocative expression of our objectives for historical computers. The committee felt that it would attract attention, and be more memorable than some more traditional title such as "The Journal of the Computer Conservation Society".

We plan to publish Resurrection quarterly. We expect the contents of future issues to follow the pattern of this first edition, with CCS news up front, features principally based on our meetings in the middle, and reports of CCS business and future plans at the back.

Resurrection will be supplemented by a posting to members of a notice of each meeting about 10 days in advance. We have found this procedure to be very effective in other BCS groups.

I trust you enjoy reading Resurrection, and agree from its contents that our society has made good progress since its inauguration. We now have some 150 members, and our numbers are steadily increasing.

We have four corporate members - Bull, DEC, ICL and Unisys. In addition, Allied Lyons has made a one-off contribution of £2,500. These financial contributions, together with that of the BCS and the facilities provided by the Science Museum, have meant that we have not had to ask individual members for a subscription.

Activities so far have including two most successful society meetings, both reported in the following pages. The Committee has been very active, and has so far found it necessary to meet monthly. We have seven working parties, and a most promising programme of future meetings.

I think we can claim that all of this adds up to a most satisfying start for our society.

If you have any suggestions or queries please get in touch with our secretary, Tony Sale. He can be contacted by post or phone at the Science Museum, or in person at our monthly meetings. Tony has arranged facilities with an inexpensive restaurant for members who wish to eat after our meetings while continuing discussions with the speaker.

Society news

Tony Sale, Secretary

There has been so much activity and response to the formation of the CCS that your committee has been meeting monthly since September last year! I am delighted with this, but it has created problems for me in coping with it all. If some of you have been waiting for replies to your letters, I can only apologise. I am slowly catching up.

You will be pleased to know that we now have over 160 members and that among these are a very good number of younger people. This is most important if we are to achieve our aim of technology and skills transfer from the early engineers to a younger generation.

Your committee is currently working on the 1990/91 programme of meetings, starting in October with an Open Day, which will provide an opportunity for members and guests to view, hopefully working, the Pegasus, the Elliott 803 and the DEC PDP-8.

We have also been much concerned with doing something about software. This is a very difficult topic and we are very fortunate in persuading Martin Campbell-Kelly to chair a Working Party on it. Our evening meeting on 28th June will provide an opportunity to fully discuss some of the issues involved and to provide terms of reference to Martin's Working Party.

Another topic of concern is the videoing of interviews and group discussions with the early pioneers. Dan Hayton and I have been pursuing this. We have had one technical trial in the Fellows Library at the Science Museum. This was only partially successful since the resolution and performance of the Museum's video cameras was not really adequate. We also realised that much more work would have to be done on preparing questions and topics for the interviews and discussions. These may be revealed by the May 24th Seminar. If anyone feels able to handle interviews at this technical level we would welcome their assistance.

If anyone has high resolution video equipment or knows anyone with facilities that we might be able to use (preferably free!) we would be most grateful. It is important that we do the directing since we are trying to produce an historical record, not a commercial video.

Working Parties and restoration work

The Pegasus has been in the restoration room in the Old Canteen building at the Science Museum since late last year. Unfortunately we have been held up because of building work converting part of the Old Canteen to offices. We had to cover up Pegasus to stop dust getting in. Thankfully that is now all finished and restoration work has restarted on Pegasus. The Elliott 803 and PDP-8 are now also in the restoration room and we hope to start on them soon.

We could do with more active members on the Working Parties. Remember that not all jobs are highly technical and there really is something for almost anyone to do. Young people in particular, can work in apprentice mode and learn some useful skills, particularly in fault finding where replacing the mother board is not an option!

We are also very keen to become experts in bit level emulation of the older hardware. Some work has already been done on this but much more needs to be done. If you like bit twiddling on a PC and fancy the challenge, contact Adrian Johnstone, who is also Chairman of the DEC Working Party. You can attach yourself to a Working Party in order to find out how the real hardware really worked.

George Davis has made a start with Pilot ACE in recording maintenance procedures used on the early computers. If we are able to build replicas at some future date, then these procedures will be essential to actually make the replicas work. Anyone interested in helping please contact George Davis.

We need to form Working Parties to examine the feasibility of restoration for the Elliott 401, the Stantec Zebra and the CDC 6600. I have also collected a wide variety of Visible Record Computers; Olivetti, Philips and Burroughs. I programmed these myself in the mid 1970's and am interested in getting them all working. Any help would be appreciated.

Computer Conservation Society - birth...

Nicholas Enticknap, Editor of Resurrection

The Computer Conservation Society is the brainchild of Doron Swade, curator of computing at the Science Museum. But it took the work of several others to bring the new organisation into being. The birth of the society was registered on 13th September, and life started in earnest a month later, when the inaugural meeting got to grips with the work that needs to be done.

Swade contacted the British Computer Society for support, and found immediate enthusiasm for the concept from Dr Roger Johnson, Vice President (Technical and Specialist Groups) and Tony Sale, who was at the time head of the Technical Division at BCS headquarters.

The three men formed a start-up committee with two former Society presidents: Ewart Willey, who agreed to act as the first chairman of the CCS, and Professor Sandy Douglas, himself a distinguished computer pioneer who traces his involvement with computers back to 1950. Tony Sale agreed to take on the responsibilities of secretary.

The committee then laid the necessary groundwork for the new so ciety. They drew up a constitution, and secured recognition as a Specialist Group of the BCS, which was granted on 13th September 1989. They also organised two meetings, an inaugural meeting to get conservation work going on 12th October, and a launch meeting to secure funding on 7th November.

The inaugural meeting of the Computer Conservation Society took place in the main lecture theatre of the Science Museum. Doron Swade's idea was clearly popular, and the start-up committee had done their work well, for no less 67 people attended.

Chairman Ewart Willey opened proceedings by welcoming the conservation enthusiasts, and outlining the aims and objectives of the new society. (These are printed on the inside front cover of this bulletin)

Doron Swade then provided a flavour of the work to be undertaken by describing the way the Science Museum handles historic objects. He also illustrated some of the difficulties that arise when an object has to be restored to working order.

Roger Johnson reported on the constitutional status of the CCS. He said that the new society had been recognised as a Specialist Group of the BCS, and outlined the financial and administrative benefits of this arrangement.

The preliminaries over, Tony Sale described the work programme so far formulated, and asked for volunteers to help with the work both of the society's governing committee and of the working parties.

The response was gratifying. A larger committee was formed to help with the work of running the society. In addition, five working parties were set up, each with a chairman. They cover Pegasus; Elliott 803; S100 bus; early DEC systems; and the Totalisator. An encouraging number of younger people we?e keen to help with the working parties: the society is particularly keen not to be seen merely as a club for reminiscing about the good old days!

The names and addresses of all committee members and working party chairmen are printed on the inside back cover of this bulletin.

Other issues discussed at the meeting included the building of emulators, in software, of early computer architectures; and the documenting of maintenance procedures of early computers. George Davis agreed to make a start on this latter work drawing on his experience of the Pilot Ace.

... and christening

The CCS held a launch meeting to meet two major objectives. We wanted to attract funding by encouraging commercial companies to become corporate fee-paying members, and we wanted to secure maximum publicity for our aims.

The event, held in the Fellows Library at the Science Museum on 7 November, went well on both counts. Four companies - Bull, DEC, ICL and Unisys have signed up as corporate members, paying fees of £1000 per annum. Negotiations are proceeding with a number of other companies who were also represented.

Possibly more important was the presence of over 25 computing pi oneers, representing between them the design teams of virtually every early British computer. Many others who were unable to attend sent messages of support and goodwill.

The most senior person present was Dr Tom Flowers, designer of Colossus, the World war II code-breaker which was possibly the first digital electronic computer of all. This unique gathering attracted full page coverage in the 30 November issue of Computer Weekly.

The guests were addressed by the Director of the Science Museum, Dr Neil Cossons; the President of the BCS, Mrs. Steve Shirley; and CCS chairman Ewart Willey.

Neil Cossons welcomed the co-operation between the Museum and a professional body. He said that working examples of old computers could ease the task of presenting the history of IT to the general public.

Steve Shirley noted that the CCS gave BCS members a focus for recording their history. She said the society built on and extended previous successful co-operations between the BCS and the Science Museum.

EDSAC designer Professor Maurice Wilkes replied on behalf of the pioneers, saying what a splendid idea it all was and why hadn't someone thought of it before!

To mark the launch of the society Professor Wilkes then presented Dr Cossons with parts of the first Cambridge Ring, the first high speed computer networking system designed and built at Cambridge in the early seventies.

Obituary

The Society has heard with great sadness that Bob Rhodes of the Pegasus Working party died on the 12th of March. Bob was held in the highest regard by all who knew him, both for his contribution to the early stages of this project, and also for his readiness to help and his unfailing sense of humour. His passing leaves us with a great sense of loss.

Computer Conservation and Curatorship

Doron Swade, Curator of Computing, Science Museum

The activities of the Computer Conservation Society at once overlap, complement and extend those of the Science Museum. The purpose of this piece is to explore, and where possible, clarify the relationship between the two organisations.

The aims of the Society are to restore to working order early computers, and to preserve working practices and the operational culture of the communities that built and serviced early machines. The spirit of the Society's conception is fresh in the minds of its founders and its aims are explicitly formulated in its charter that of a specialist group of the British Computer Society. The aims of the Science Museum, on the other hand, have been formulated differently at different times. In the last century the founding ideal was to promote the values of industrial society by displaying the best examples of the 'industrial arts'. Since then, science education. material culture, and more recently, 'public understanding of science', have featured variously in the formulation of corporate intent. We can sense a general harmony of purpose between the fledgling So ciety and its cultural host. But the overlap is diffuse. Where, in practical terms, do these two ventures combine, differ or even conflict?

The Museum has many identities temple, warehouse, fairground. In whatever way museums are perceived they are essentially about people and things. The 'things' that presently concern us are the machines in the Computer Collection; the 'people' are curators and museum staff on one hand, and the members of the Society its working parties and support groups on the other. The two groups have different relationships and attitudes to computers. How do they compare?

'Inventoried objects' occupy a special place in the Museum's landscape and their role and status are frequently not well understood outside the museum profession. An inventoried object is one that has been formally admitted into the Museum's care by an inventory procedure which transfers the 'title' of the object from the donor/lender/vendor to the Museum. Each inventoried object is the direct responsibility of a named curator, the collecting officer, who signs a formal declaration of responsibility for the object when it is acquired. Such objects are subject to formidable safeguards against disposal and unqualified alteration and the curator is legally and professionally responsible, via a chain of accountability line management, the Director: and the Trustees - to the Minister for Arts. A forbidding tale. A consequence of particular interest to the Society is that in ordinary circumstances the curator, as collecting officer, is the only person empowered to authorise physical access to an inventoried object in his or her care.

The curator's brief, and the object of these fearful procedures, is to preserve the object for posterity - a period conveniently not quantified but taken to extend beyond the professional span of any given incumbent. Ordinarily preserving the object amounts to securing benign storage conditions to prevent, or at least retard, physical deterioration. The assumption throughout is that the object remains unaltered in an essentially passive environment. The Society, however, proposes to restore machines to working order. Restoring a computer, as distinct from conserving it, more often than not requires physical intervention. The process may well involve recabling, reconfiguring, repair, renewal of parts, or modification. Operating the machine on a routine basis, even if only for demonstration purposes, will run inevitable risks: physical damage through accident, and gradual destruction of moving parts through use.

The traditional culture of museums is essentially conservative and protective. The safeguards, procedures and formalised chain of responsibilities are designed to protect the physical integrity of objects and thereby their historical authenticity. How do we reconcile the aspirations of the Society (and those of its curator of Computing) with the 'sacred relic' tradition that renders objects inviolate? First we must examine the desirability of restoring computers and then address the issue of how we can responsibly extend rights of access to the Society's members who, though outside the formal chain of curatorial accountability, often have more expert knowledge of specific machines than the official custodians.

The internal model of curatorship is essentially archaeological - the reconstruction of circumstance and context from limited physical evidence. The physical residue of earlier cultures provides limited clues to the past. The antiquity, incompleteness and relative rarity of relics afford them a certain reverence. However, many of the earliest electronic computers are still within living memory. Most are well documented and their creators and implementors are still hearty if not hale. The antique past of electronic computing is not yet inaccessibly distant. We remain sufficiently close to the technology and its culture for early electronic machines to invite amused and sometimes wry nostalgia rather than the awed reverence accorded to relics from an unrecoverable past. My argument is that these machines are not yet the fragile sacred relics of the archaeological model which presupposes separation by an unbridgeable gulf of time. Electronic computers occupy a window of recency roughly one professional lifetime wide and it is both proper and responsible to review the appropriateness of existing practice and attitudes to these artefacts.

The curator of Road Transport recently observed that there is already an element of ambiguity in curators behaviour towards their machines Certainly some actions seem closer to vandalism than hands-off reverence: sectioning engines and pumps for the purpose of education and display, accelerating the

deterioration through wear of vintage cars by running them, placing them at risk by taking them on public roads, renewing parts with non-original components manufactured using modern materials and methods, and restoring them to pristine external condition (paintwork, upholstery) thereby tampering with the historical evidence and altering aspects of provenance, It seems then that not only is the archaeological model not the best fit for electronic computers on the grounds of recency, but the archaeological model is not universally subscribed to even in the museum world

Why is it desirable to restore an early computer? The first stage of operational restoration is physical reassembly. It hardly needs arguing that the datum of physical integrity should be as close to the operational state of the machine as possible, However, large and medium-sized computers are invariably uncabled and dismantled into manageable units for purposes of transport from donor's site to store. Machines treated in this way include the Ferranti Pegasus. the Harringay, Wembley and Ipswich Totalisators, the Elliott 401 and 803. and ERNIE I and II, Paradoxically the act of acquisition is the most traumatically destructive process in the life of the supposedly prized machine, Physical reassembly after acquisition can be seen as a healing process - an attempt to restore something of what is lost in rupturing the machine from its operational habitat. It is part of rehabilitation for retirement - a bona fide episode in the natural life of the machine. Physical reassembly, the first stage of restoration, is not therefore an anti-historical intervention hostile to preservation that degrades a machine sanctified by the inventory procedure. Quite the reverse - it establishes a datum of greater historical probity than would otherwise be the case,

A reasonable guardian of procedural sanctity would, I believe, find physical reassembly unobjectionable and even desirable. However, restoring an assembled machine to working order will often involve radically controversial action - reconfiguring the system, recabling, and replacement of damaged parts. It is here that we face real issues of judgement and potential conflict that send traditionalists, brows furrowed, reaching for the museum professional's handbook of approved practice.

The serious 'archaeological' purpose of the Museum's activities is to preserve machines for future generations of curators, historians and scholars. The lessons and messages these machines embody for our successors, and the line and focus of their enquiries, are unforseeable, If we replaced rubber-sleeved or fabric-wound cable with PVC on the grounds of availability or safety might we not mislead some future enquirer researching, say, the introduction and use of plastics in electrical insulation? Original spares (cable terminators, lugs, capacitors, selenium rectifiers, ...) may not be available. Is posterity better served by a machine that works (or has worked) using non-original parts, or by a machine that is intact but in an uncertain state of completeness with respect to electrical detail? These are more than merely

rhetorical issues. There are no universal solutions on offer. We are breaking new ground.

My purpose in dwelling on curatorial issues is twofold: to sensitise the Society's membership to the considerations of historical authenticity that apply to computers in the Museum's collections - considerations that do not ordinarily apply to machines in commercial, scientific or engineering environments; secondly, to reassure my colleagues in the museum profession that we are acutely aware of the museological issues agitated by these activities and that clearance procedures and working practices have been devised to safeguard curatorial responsibility.

The pioneers, engineers and technicians who built and serviced these grand old machines are those best qualified to restore them. The venture provides us with a unique opportunity to capture know-how, expertise and narrative history. The activities of the Society allow us to explore, for the first time, a range of technical, historical and museological issues, We have only just begun. I, for one, relish the prospect of what- is to come

ICL and the British computer industry

Dr Martin Campbell-Kelly, Chairman Software Working Party

On 22nd February 1990, Martin Campbell-Kelly of Warwick University gave the first evening lecture for the Computer Conservation Society. His talk, summarized below, was based on his recently published book "ICL: A Business and Technical History

The history of ICL can be divided into three major periods: the punched-card era; the formation of ICL during 1959-68; and the history of ICL itself since 1968.

The punched-card era, c. 1900-1959

In order to understand the history of ICL, it is necessary to appreciate that both ICL and IBM have a common ancestor, and that for over forty years they had something of a love-hate relationship.

The era of modern data processing really began with the invention of the punched-card tabulating machine by Herman Hollerith in the 1880s. The firm he created to market his machines eventually became International Business Machines. In 1907 a London-based syndicate formed the British Tabulating Machine Company (BTM) to market the Hollerith machines in Britain and the Empire. BTM was never remotely as successful as IBM and this was the source of much friction between the companies. Not the least cause of this friction was the fact that BTM had allowed a rival, Powers-Samas, to achieve a 50 per cent market share of the British punched-card machine market.

In fact, as a result of the competition between BTM and Powers-Samas, a flourishing British punched-card machine industry developed between the wars that was a major force in the world-wide office machine industry. Both companies developed their own designs, and had R&D facilities that were amongst the most advanced in Europe.

During World War II R&D remained very much to the fore in the punched-card machine companies - but it was directed to the war effort rather than office machine&. BTM in particular designed and built the "Cantab" code-breaking machines that were used to break the German Enigma codes. Project Cantab remained a total secret until the 1970s and few concrete details of the machines have ever been released; the drawing in Figure 1,

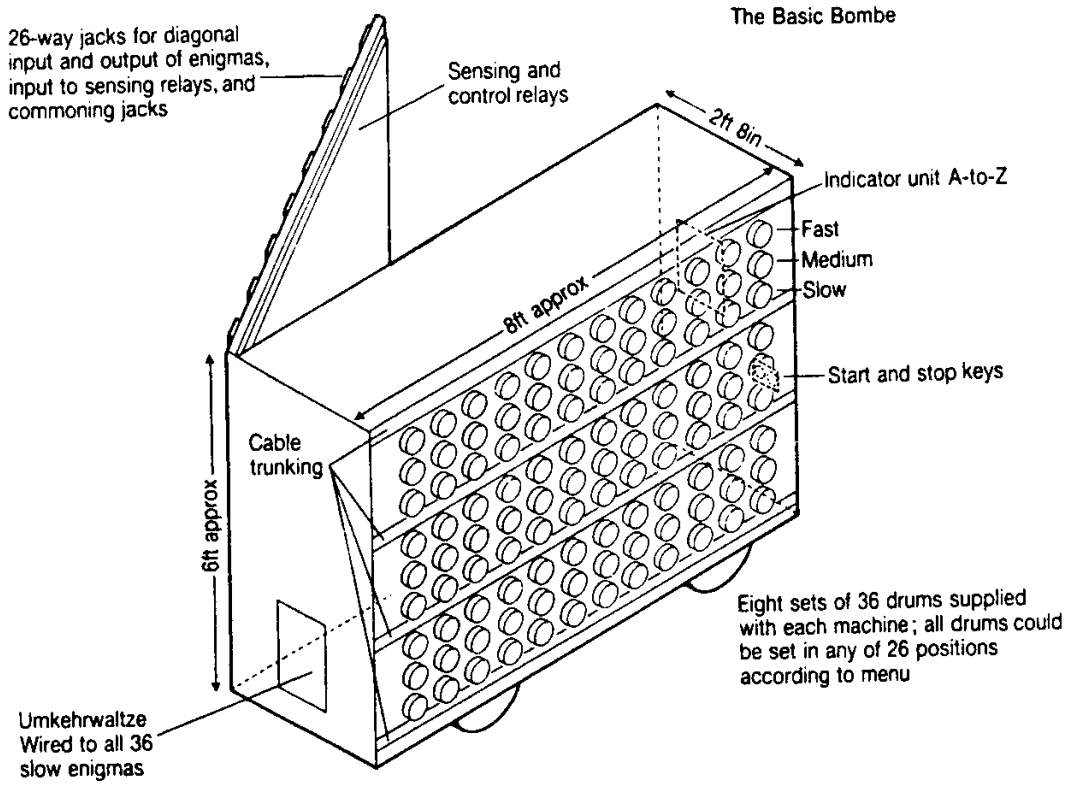

Figure 1: The BTM Cantab code-breaking machine, c.1943

certainly the most authoritative ever published, is based on a sketch provided by a former BTM employee who worked on the machines.

When BTM and Powers-Samas emerged from the war, they were faced with two formidable R&D challenges: the emergence of electronics and the invention of the computer. Taking their lead from IBM, they initially ignored the computer and instead incorporated digital electronics into their existing punched-card accounting machines. This was a major strategic error that lost both companies and IBM - the opportunity of establishing an early domination of the market for data processing computers.

The year 1949 was a watershed for the British data-processing industry. For in that year BTM and IBM decided by mutual consent to break their long-standing agreement, and go into open competition world-wide. So far as BTM was concerned the end of the agreement would mean the end of paying royalties; this would enable them to at least treble their R&D spend and thus develop products they believed would match any that could he made by IBM. In hindsight this seems an extraordinarily naive judgement but it must be remembered that IBM was not then the giant company it is today; and BTM had no appreciation whatever of the computer revolution that was about to unfold.

The formation of ICL, 1959-1968

By the late 1950s, the data-processing computer had begun to emerge as a serious office machine; one which called for an escalating level of R&D funding. Moreover, IBM was now making big inroads into the British and Commonwealth data-processing markets. It was in order to meet these challenges that BTM and Powers-Samas decided to merge in 1959. By this time the eventual ascendancy of computers was plain for all to see, and was implicit in the name chosen for the new company - International Computers and Tabulators Limited (ICT).

The punched-card machine manufacturers had not, of course, been the only entrants into the computer business during the 1950s; there were also the electronics and control manufacturers who included Ferranti, English Electric, EMI, Elliott Brothers and several others. All these firms had prospered quite well until the advent of second-generation computers at the beginning of the 1960s. To compete with the products that were now being delivered by IBM and the other big American companies, the British manufacturers had to develop their own second-generation computers.

To simplify what is really a very complex story, every manufacturer was faced with the same business decision: either to stay in computers for the long-haul and accept heavy short-term losses; or to sell out while the going was good. One by one the different companies made their decisions,, so that the merger wave of 1960-63 left just three UK computer manufacturers - ICT, English Electric and Elliott-Automation (Figure 2).

But this was not the end of the consolidation by any means, for in April 1964 the whole economic basis of the industry was transformed by the announcement of the IBM System/360 range of third-generation computers. It was estimated that the R&D spend for System/360 was of the order of $5 billion. At this point, all the mainframe manufacturers world-wide were forced into announcing computer ranges of comparable performance.

ICT's response to System/360 was to announce its 1900 series in September 1964. The 1900 series was in fact derived from a machine developed by Ferranti-Packard in Canada, and was initially something of a tactical stop-gap; but it proved to be an enormous commercial success that

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BTM --- ----------- ----------,                          EEL  English Electric Leo
                        1959  |-- ICT --,                 EELM English Electric-Leo-Marconi
Powas-samas ----- ----------'          |                  EEC : English Electric Computers
                                 1961  |-- ICT --,
GEC Computer interests -- ----------'          |
                                          1962 |-- ICT  - ,
                                               |          |
EMI computer interests---- ---------- ----------'          |
                                                 1963  |-- ICT-- ---------- ---------- ,
Ferranti EDP computer interests  --- ---------- ----------'                              |
                                                                                         |
English Electric computer interests- ----------,                                1968  |---  ICL
                                          1963  |-- EEL - ,                              |
Leo Computers--- ---------- ---------- ----------'          |                             |
                                                 1964  |-- EELM --------- ,             |
Marconi  computer  interests -------- ---------- ----------'                |             |
                                                                      1967  |-- EEC- '
Elliott-Automation --------- ---------- ---------- ---------- ---------- ----------'
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Figure 2: The evolution of ICL

soon enabled ICT to dominate the British computer market. English Electric decided to produce an IBM-compatible range of computers known as System 4 which was itself derived from the RCA Spectra 70 range.

These developments took place against a backdrop of growing political concern at the increasing dominance of the high-technology industries by American multinational companies. When, in October 1964, the Labour Government came into power, Prime Minister Harold Wilson determined to achieve a rationalisation of the British computer industry which he feared "would rapidly cease to exist"

In fact it was more than two years before a national-flagship computer company, International Computers Limited, finally took shape. To help smooth the path the government had held out the promise of a grant of £25-30 million to develop a new range of computers for the early 1970s In the event, due to intervention from the Treasury, only £13.5 million was provided. ICL was vested in July 1968. With a workforce of 34,000, it was the largest non-American computer manufacturer.

ICL's recurring crises, 1968-85

For ICL the scene for the 1970s was set by a mission to develop a new range of computers, but with R&D resources that were not really sufficient. Almost as soon as the New Range development got underway, ICL was hit by the the computer recession of 1970-71. To maintain the momentum of the R&D

programme, the government somewhat reluctantly provided a loan of £40 million.

The New Range was finally launched in October 1974 as the 2900 series. This was some two years later than had originally been anticipated, due to the funding problems and the usual development delays; but ICL now had a computer architecture that was the most modern available from any of the mainframe manufacturers (and this arguably remains true today)

On the basis of the 2900 series and its small business systems the ICL 2903, and the System Ten acquired from Singer the remainder of the l970s was a very good period for ICL. It achieved an annual revenue growth of 20 per cent right up to the end of the decade.

In 1980-81, however, the UK underwent a major economic recession; ICL's profits evaporated and once more it had to turn to the government for aid. At this time, ICL's major problem was the widening gap between its earnings and the R&D expenditure necessary to keep its products competitive. Whilst previous governments had provided direct R&D support, this was not the route chosen by the new Thatcher administration. Rather, the view was taken that ICL's shareholders and bankers should save it; but they were less than keen. Eventually, in March 1981, the government agreed to provide loan guarantees of £200 million and the institutions provided the necessary funds.

There followed during 1981-84 the most traumatic period of ICL's history: the head count was cut from about 33,000 to 20,000; the entire organization of the company was restructured; the R&D programme was rationalized; and ICL embarked on a whole series of collaborative ventures. By far the most important of the latter was a link with Fujitsu which enabled ICL to use Japanese state-of-the-art semiconductor technology for its Series 39 mainframes, to replace the ageing technology of the 2900 series.

In parallel with this rationalization and restructuring, ICL was actively seeking a merger with a telecommunications company, which would give it greater scale to compete with American and Japanese suppliers, and the ability to exploit the coming convergence of communications and computers. None of these early talks were successful, but in July 1984 STC launched a takeover bid for ICL; and in a matter of weeks, ICL had been absorbed as an operating division of the STC Group.

As a part of the STC Group, ICL has now opened a new and promising chapter in its history; although - ranking only twentieth in the world league table of IT firms - it remains a relatively small player on the world stage. ICL has always eschewed being a 'niche' computer firm; assuming it wishes to stay this way, it will ultimately have to maintain a parity of size with the other multinationals. This it will do by acquisitions, mergers and organic growth.

That said, however, the evolution of the British IT industry appears to be 'chaotic' in the technical sense; it is quite impossible to predict how things will turn out in anything other than a very short time-frame.

Audience discussion of Dr Campbell-Kelly's paper centred mainly on the shortcomings and missed opportunities of ICL over the years, with Dr Campbell-Kelly explaining the reasons, so far as possible, from ICL's viewpoint.

A number of speakers felt that ICL did not support their customers sufficiently. E Willey thought this was the case in the days of Orion. Dr Campbell-Kelly said that, having recently acquired Ferranti, they did not have the resources. Mr Penson felt that programming support was lacking. Dr Campbell-Kelly pointed out that support was available for their largest customers, but they hadn't the resources to support all their customers. In fact they capitalised on programs developed by amateurs. ICL's marketing had been very weak compared with IBM's, but their manufacturing costs were 50% whereas IBM's were only 20%. Reliability of ICL products was not as good as IBM's but, as Dr Campbell-Kelly pointed out, ICL products used more advanced technology. ICL was constantly inhibited by a smaller market (and hence smaller volume of production) as compared with IBM; though even in Europe (in 1975) the government funding for home-grown computers was: Germany £275M; France £100M; UK £37M (of which ICL got half).

Some other points. A Johnstone thought ICL would have done better concentrating on office computers rather than mainframes. G Scarrott thought the success of the 1900 was due to its derivation from the FP1600, in turn derived from Orion and Pegasus. Orion provided an effective time-sharing system which was not matched in the IBM range. Neuron technology was used to get the maximum logical power per transistor because of the high cost of transistors; however it proved unreliable due to the need for close tolerance in the transistors. He also thought the recovery in 1980-84 was due to CAFS (the Content Addressable Filestore) which was also used in running the company.

Making Pegasus Fly

John Cooper, Chairman Pegasus Working Party

The machine the museum and society have selected as the first machine to restore is Pegasus, specifically machine number 18.

This machine was installed at Skandia in Stockholm during August 1960. However due to difficulties with ancillary apparatus it was returned to Manchester& in August 1961 and used for development work. Just over two years later in November 1963 it was donated to University College London, where in January 1964 it was installed in the Chemistry department and was used for crystal structure analysis. The last entry in the maintenance log is 23 April 1980 and on 21 November 1983 the machine was dismantled and returned yet again to Manchester, but only for safe keeping on behalf of the Science Museum to whom it was donated but at the time had nowhere to store it. After recommissioning at Manchester in January 1984 it ran successfully until the Museum was able to accommodate it. The last entry in the log reads "farewell to West Gorton 17 January 1988". It lay in store until the start of this project in November 1989.

Why choose Pegasus to start this project? I think there are a variety of very good reasons for the choice and a good way of examining them is to look briefly at the history of Pegasus and the way it works.

Pegasus was a late first generation computer using thermionic valves, and as a result of Christopher Strachey's work on the Elliott 401 and his persuasion of NRDC that a far more ambitious machine could be developed, a design team was set up by Ferranti in mid 1954 with an NRDC contract for 10 machines. The team, based in London, was headed by W 5 Elliott and work started on what was then called the Ferranti Packaged Computer. (The initials F.P.C.1 are on the front covers of the engineering manuals that came with number 18.)

Features originally specified by Strachey were that optimum programming was to be minimised or avoided; and that the instruction set be governed by the needs of the programmer and not limited by engineering expediency. These features were attained by using a magnetic drum as a main store coupled to a relatively fast nickel delay line computing store from which the instructions were obeyed under the control of the processor. In a little more detail, the machine can be broadly divided into three main parts: the main store, a magnetic drum with a capacity of 5120 42-bit words accessible as 640 block of eight words each; a computing store of 48 words arranged as six blocks of eight words each with a set of eight accumulators/modifiers; a processor consisting of two parts, an arithmetic unit or mill which performs

the instructions and a control unit or programme counter which sequences the instructions.

Each word in the machine, be it instruction or data, is operated upon serially, that is one bit at each clock time. This is very different from the modern practice of working in parallel, which operates on all the bits in a word in one clock time, a technique only made practicable by the use of semiconductors.

The processor obeyed instructions sequentially from the computing store. Therefore to run a program the instructions were loaded block by block from the drum into the store and the sequence started. While a program was obeyed from the computing store its operating time was independent of the drum, thus freeing the programmer from the need to optimise, or at least until new blocks was required. However consecutively addressed blocks on the drum were interleaved to automatically optimise their sequential transfer. Therefore the possible delay of one drum revolution per block was reduced to only the first block in the sequence.

Each instruction was allocated 19 bits and contained three address fields and a function. Two instructions are packed into one word giving the programmer 96 instruction in a full computing store. Having the ability to address and index from any of the eight accumulators, and access any computing store location in a single instruction, greatly reduced the problems encountered in earlier machines using a single accumulator, in which a large proportion of the instruction sequence was concerned in just organising data. A range of 51 instructions were available on Pegasus 1 which included, Load (from address and literal), Boolean operations, Add/subtract (the result in either address), multiply/divide, Shift (logical and arithmetic), and a range of special operations, such as unit count and jump on condition in one instruction, and normalise to assist in floating point operations. The provision of these instructions enabled the programmer to produce very compact programs, and the structure of this code had a strong influence on the Ferranti Packard 6000 and hence the ICL 1900 series of computers.

The hardware used the modular or packaged approach in the construction of its logic elements, although this method was criticised at the time for its creation of redundant hardware and potential connector problems. However this structure resulted in a machine which proved fast to repair and facilitated its subsequent development. Another factor which contributed to the reliability and user confidence in the machine was the use of a parity check on all data and instructions. It worked by counting all the bits set to one in a word and altering the parity bit to make the count even when data was generated. An error was flagged and the machine halted if any subsequent transfer produced an odd bit count. This feature I believe was included at the

insistence of W 5. Elliott, and assisted greatly in the location and rectification of faults.

A great deal of effort was put into what we would now call the user interface by the provision of extensive monitoring and handswitch control facilities, both for the programmer and engineer. The features included single instruction stepping, the ability to look at the contents of every location in the computing store, all accumulators and special registers. The instruction display is particularly worthy of mention as it split the word into two parts and presented each instruction divided into octal address and function fields. Again this greatly assisted in both correcting programmes and finding machine faults.

Software and engineering documentation support was very good, and the Pegasus Programming Manual by G E Felton must be mentioned as providing users with a very clear insight into the machine operation.

The first Pegasus was put into service in 1956 and was used by Ferranti to start the first computer service bureau in Britain, at Portland Place in London.

I think this brief look at Pegasus indicates that the ambitions of Christopher Strachey were realised through the design team at Ferranti headed by W.S.Elliott. This made Pegasus a significantly outstanding machine and established methods and practices used in many later computers. Its total sales of about 40 from 1956 to 1961 also indicate the lead and popularity it had in the market place. Also everybody I have met who had the good fortune to work with Pegasus developed a great affection for it. These factors I think make it the right choice for restoration.

How far have we got with the restoration? The group has met four times. At the first meeting the ground rules for contact with the machine were made, the machine was inspected and a method of working using task sheets was established. An initial 15 tasks were identified. The second and fourth were evening meetings to start what we thought an essential job, the cataloguing of engineering documents and manuals. To date about 95% of the documents have been entered into a database, and nearly all the manuals listed in preparation for entry. The third an all day meeting to work on the machine. The machine is resting on wooden blocks which raise it above the floor: this has been done so that it may be moved easily, but has introduced a problem. The cooling system relies upon the base of the machine being sealed by it resting upon a solid floor. To solve this problem infill panels have been fitted to the main unit. These were made of hardboard and fitted but still require sealing with tape. The power bay is a little more difficult as there is no room to fit panels inside the unit due to the internal transformer mountings. We plan to resolve this by fitting a large panel to the underside of the bay: a panel is being made. The refrigeration pipe work is being dealt with by a contractor.

It has been pressurised but we have not been able to test the compressor as there is no mains supply yet. We have been unable site the motor alternator away from the machine, which means that when the machine is running a very great deal of noise will be generated close to the operating area. To try and direct the noise away, the mains distribution panel has been placed between the machine and the alternator. The interbay and power control cable ducts and cables have been put into place but no connections made. The alternator has been inspected and considered operational but the exciter commutator will need attention and the two phase generator brushes will need changing in the near future. The mains and alternator wiring has to be completed but the alternator needs to be mounted on shock absorbers: this is being handled by the museum who have placed the work with an outside contractor.

I hope to arrange an all day meeting in the near future to start work on the interbay connections, which I hope will run concurrently with the work on the alternator.

I would like to take this opportunity to thank the members of the group who have made this initial project possible. They are

CHRIS BURTON, ROY CRABBE, DAVID MITCHELL,
BOB RHODES, ROBIN SHIRLEY, SIMON WHITTAKER

The Young Person's Guide to... The PDP-8

Dr Adrian Johnstone, Chairman DEC Working Party

In the first of a regular series, Adrian Johnstone examines the PDP-8, giving a potted history and a programmer's reference card.

The PDP-8 first shipped in 1965, and production in one form or another continued until 1988. The last PDP-8 based DECmate III word-processors were delivered to customers in Spring of 1990. Twenty-five year production runs are almost unheard of in the computer industry, so what makes the 8 so special?

The PDP-8 design derived from the PDP-5, using new memory and logic technology that permitted substantial improvements ill performance and reduction in cost. In particular, it required only half of a standard rack cabinet, and was available in table top form at a cost of $16,200. As such it marks the beginning of the minicomputer industry.

The secret of success was that the PDP-8 was continually reimplemented using new technology to drive price down. In late 1966 a bit serial machine (the PDP-8/S) was produced that required about the same amount of space as a filing cabinet drawer and cost $8,790. Its performance was only about one tenth of the straight-8, and it was not a commercial success. In 1968 the PDP-8/I appeared, followed by the rack mounting PDP-8/L. These machine offered better performance at between half and three quarters of the cost of the straight-8.

These machines helped create the OEM computer market with PDP8s being incorporated into scientific and engineering equipment by other manufacturers. By the end of the 1960's there was a clear need for more flexible systems that would allow the customer to mix-and-match 1/0 interfaces and tailor the computer to their own particular needs. The PDP-8/E produced in 1971 was the first bus-based machine. It cost only $5,000 and had space for almost 30 Omnibus modules. The 1972 PDP8/M was basically the same machine in a half-sized chassis which cost $1,500 less. The most evolved full-scale machine, the PDP-8/A appeared in 1975. A floating point option was available, with performance comparable to the IBM 360/40.

In the early 1970's DEC had started to design a PMOS single-chip PDP-8. This project was stopped in Summer 1973, partly as a result of the industry shift to NMOS technology. However, in 1976 Intersil produced a PDP-8 on a CMOS chip which was later second-sourced by Harris. This was the first DEC processor to be built on a single chip, and was incorporated into the VT78, a VT52 terminal with a PDP-8 built in which could support up to five terminals and external mass storage. It cost $11,600 for an 8Kword system

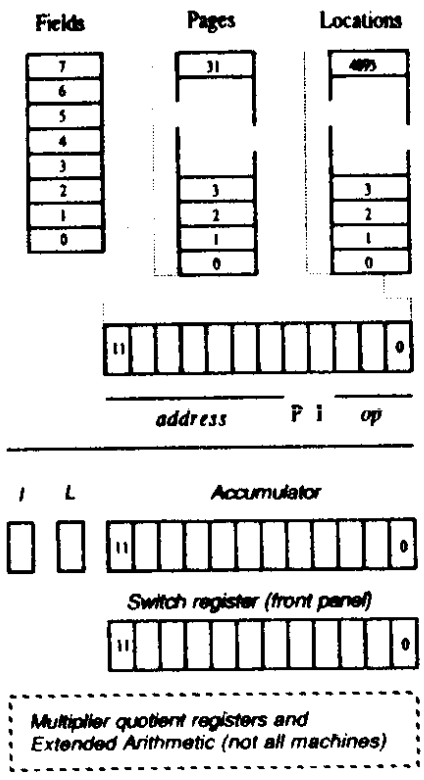
with mass storage in 1977 (all other prices given here refer to basic 4Kword systems with no terminals or storage).

Most PDP-8s have about the same compute performance except for the unloved PDP-8/S (about 0.1) and the VT78 (0.4). Their 1/0 throughput and flexibility vary significantly but more importantly the cost varied from 16,200 1965 dollars for the stralght-8 down to 2,600 1975 dollars for the 8/A. This machine created its own market and is the direct ancestor of today's personal computers. The society is restoring an original straight-8 for the Science Museum, and has recently been donated a working VT78.

Programmer's Reference

PDP-8 instructions have a 3-bit op code field, a 7-bit address field, a page bit and an indirect bit. The M address is constructed from the address field concatenated with the top five bits of the current program counter and the three bit field address. If the page bit is 0 then the five bit page field is set to zero, generating addresses in the first 128 words of memory. If the indirect bit is set, indirect addressing is used. There is a single accumulator with a Link bit to store carries. Eight of the memory locations in each field's page zero autoincrement after each access. Later models have a multiplier and extended arithmetic capability. Switches on the front panel form a read-only Switch Register. The eight basic instructions include OPR which allows any combination of the operations listed in the tables below to be executed in a single instruction.

Register set and memory addressing



Instruction set

Main opcodes

0 AND A:=A and M
1 TAD A:=A + M
2 ISZ M:=M+1; IF M=0 THEN PC:=PC+1
3 DCA M:=A; A:=0
4 JMS M:=PC; PC:=M+1
5 JMP PC:=M
6 IOT -- see IOT microinstructions
7 OPR -- three groups of microinstructions

Group 1

NOP No operation
CLA A:=0
CLL L:=0
CMA A:=NOT A
CLL L:=NOT L
RAR Rotate A and L right
RAL Rotate A and L left
(rotate by 1 or 2 positions)
BSW swap bytes in A
IAC increment accumulator

Group 2

SKP skip unconditionally
SMA skip IF A<0
SZA skip IF A=0
SZL skip IF L=0
(reverse skip condition)
CLA clear accumulator
OSR A:= A OR switch register
HLT Halt

Group 3 (not all machines)

NOP No operation
CLA A:=0
MQL MQ:=A; A:=0
MQA MQ:=MQ OR A
CAM MQ:+0; A:=0
SWP swap MQ and A
ACL A:=MQ

IOT microinstructions

SKON IF I=1 THEN skip; I:=0
ION I:=1
IOFF I:=0
SRQ IF request THEN skip
GTF Get flags
RTF Restore flags
CAF Clear all flags

Skills and Objects Wanted

SAFT battery for the Elliott 803, Nickel Cadmium

Paper tape copy of Tony Hoare's ALGOL compiler for the 803

Any Williams Tube memory bits, particularly from the IBM 701, 2 or 4

Enthusiasts for the Totaliser Working Party

Experienced Elliott engineers and users

Forthcoming Events

Thursday 28th June

Software Working Party discussion forum

Evening meeting at the Science Museum starting at 17.30 chaired by Dr Martin Campbell-Kelly. This is your opportunity to set the goals and working practices for this important working party

Thursday 11th October

CCS Open day at the Science Museum - come and view progress on restoration

Thursday 15th November

Joint meeting with the BCS Advanced Programming Group celebrating the thirtieth anniversary of Algol.

Resurrection is the quarterly bulletin of the Computer Conservation Society
Editor - Nicholas Enticknap
Production Editor and typesetting - Adrian Johnstone

Printed by the British Computer Society

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