# Computer Conservation Society

## Aims and objectives

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

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

The aims of the CCS are to

- ◇ Promote the conservation of historic computers and to identify existing computers which may need to be archived in the future
- ◇ Develop awareness of the importance of historic computers
- ◇ 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 ICL and Vaughan Systems.

# Resurrection

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## Contents

**News Round-Up** **2**

**Cambridge's Golden Jubilee**
*Nicholas Enticknap* **6**

**BTM's First Steps Into Computing**
*Raymond 'Dickie' Bird* **12**

**Getting Stevenage up to Speed**
*Mike Forrest* **19**

**Obituary: Charlie Portman**
*Chris Burton* **27**

**Letters to the Editor** **28**

**Society Activity** **30**

**Forthcoming Events** **35**

**FTP, Web and E-mail Addresses** **36**

## News Round-Up

The Society celebrated the 50th anniversary of the first run by Edsac with a seminar at the Science Museum on 10 May. Society Chairman Brian Oakley introduced the event as "a celebration of 50 years since Edsac worked and also more importantly a celebration of what the Cambridge Computer Laboratory has done over the past 50 years". A report of this event can be found starting on page 7.

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The seminar was followed by a reception in the library of the Director's Suite. Brian Oakley took advantage of the occasion to pay tribute to the Society's sponsors. For the SSEM project Oakley acknowledged the University of Manchester, the Manchester Museum of Science and Industry, and "above all ICL for not just the filthy lucre but also the people". For the Bombe project he thanked AutoCad, Nortel, Quantel and the Nortel retired group. For general support of the Society's activities, Oakley acknowledged the BCS and our two corporate sponsors, Vaughan Systems and ICL.

- 101010101 -

Ewart Willey retired from the Committee at the AGM on 10 May. Ewart was the first Chairman of the Society's Committee, a role he filled till 1992. Since then Ewart, a former President of the BCS, has continued to give us the benefit of his wise counsel as a "backbench" member of the Committee. We wish him well for the future.

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All other officers and members of the Committee were re-elected by the AGM.

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Len Hewitt has been formally appointed Chairman of the Pegasus Working Party, in succession to Chris Burton. Len has been guiding the activities of the working party since Chris started work on the Small-Scale Experimental Machine project in Manchester.

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We are delighted to report that the Committee's Science Museum representative, Doron Swade, has been promoted to the post of Assistant Director and Head of Collections.

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We are grateful to Roger Middleton for the donation of two sets of magazines to the Society: one of *Personal Computer World* running from 1978 to 1998, and the other of *Byte* from 1981 to 1998. All are in original condition: where there was a floppy disc or CD-ROM supplied with an issue this is still attached. The collection was started by Dr Middleton's father Ron, who used to work for ICL, and continued by Dr Middleton himself, who is Reader in the History of Political Economy at the University of Bristol.

- 101010101 -

The Science Museum is planning to incorporate the Pilot Ace in the new Museum of the Modern World gallery, due to be opened next year.

- 101010101 -

The *Station X* series on Channel 4 television has led to an immense increase in the number of visitors to the Bletchley Park open days. As a result, consideration is being given towards opening the Park every weekend, instead of alternate weekends as at present.

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The Leo Computers Society has now set up a Web site. The address is <www.man.ac.uk/science_engineering/CHSTM/leo>.

- 101010101 -

The Leo Computers Society is organising a reunion for anyone who worked for Leo Computers, its successor companies, or users of Leo systems. It will commemorate the 50th anniversary of the start of work on Leo I. The reunion will take place in London on Friday 15 October 1999. Anyone interested should contact the Web site given in the previous paragraph for further information, or alternatively should ring organiser Peter Byford on 01920 463804.

- 101010101 -

We have received information about an Australian organisation called Back (Burnet Antique Computer Knowhow) which, to quote its own literature, "specialises in the provision of creative, interesting and memorable displays of computing icons in foyers and entrances". To provide this service, Back has a collection of computing and data processing artefacts dating back to 1910, stored in over 60 six foot cabinets, as well as over 6000 literature items. Readers wanting to know more can contact Back Pty Ltd at PO Box 847, Pennant Hills, NSW 2120, Australia, or e-mail proprietor Max Burnet at <mburnet@nsw.bigpond.net.au>.

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Does anyone know of any survivors, intact or partial, of any of the following early machines: BTM 541, 542, 550 and 555 calculators; BTM 1201 family; Powers Samas EMP and PCC; or ICT 558? The Secretary would be grateful if anyone who does would contact him with the details.

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Jack Howlett, a mathematician who played a major role in pioneering the use of computers for complex scientific applications, has died aged 86. Jack, who was best known as the Director of the Atlas Computer Laboratory at Harwell from 1961 to 1975, was also for many years a distinguished editor of the *ICL Technical Journal*. Jack was an enthusiastic member of the Society and was often seen at our meetings.

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Membership of the Society currently stands at around 670.

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**A History of Manchester Computers**

As part of the 50th anniversary of computing celebrations in Manchester last year, Simon Lavington and the British Computer Society have produced a book describing the history of Manchester University's five prototype computers built over the period 1946 to 1975.
Anybody who missed the celebrations or would like to know more about Manchester's innovations is recommended to obtain a copy of this book. Its 56 pages provide a detailed description of the five prototype computers, place them in the context of contemporary computer developments elsewhere, and are copiously illustrated with photographs, charts and program listings.
"A History of Manchester Computers" by Simon Lavington is published by the British Computer Society at 1 Sanford Street, Swindon, Wiltshire SN1 1HJ, and has ISBN number 0-902505-01-8. The price is £6.00 to BCS and CCS members, £8.00 to non-members. Contact Ian Jones, BCS Publications Manager, on 01793 417417 for further details.

## Cambridge's Golden Jubilee

*Nicholas Enticknap*

An important UK computing golden jubilee took place on 6 May 1999. Fifty years earlier to the day, Cambridge University's Edsac ran its first program, the production of a table of squares. In 2 minutes 35 seconds history was made.

The Society helped to celebrate the anniversary with an afternoon seminar at the Science Museum on 10 May. A month earlier the university ran its own commemorative event, Edsac 99, and the Society's event was based upon this.

The Cambridge story has a very different starting point from the contemporary developments at the other pioneering university, Manchester. Whereas the Small-Scale Experimental Machine project grew out of electrical engineering research, Edsac was the fruit of research into computational methods. Manchester needed to test a cathode ray tube memory, Cambridge was looking to build on computational advances made with differential analysers.

These differing backgrounds had an important influence on both the approach to and the progress of these two influential early UK computers.

Maurice Wilkes told the Science Museum audience that the starting point for Edsac was when "I was invited to the Moore School for a series of lectures on electronic computers". The potential of the Eniac/Edvac project he learnt about had an immediate impact on Wilkes, and "I began to sketch the design of Edsac on the Queen Mary on the way home".

Wilkes summarised the design principles he arrived at thus: "It was to be simple; adaptable to user needs; a serial machine, modelled on Edvac; to have a double length accumulator; and to be a fixed point machine, with a 34-bit word plus sign".

A major practical problem was the choice of memory. For Manchester University, proving radical new memory technology was the major point of the exercise; for Cambridge, producing a working computational device was the objective, and that meant using tried and tested components. But what?

Wilkes chose mercury delay lines: this decision, he revealed, "was a suggestion of Eckert's", but he added that "this was the only sort of memory that offered itself".

Wilkes himself was "what would now be called Chief Architect". Much of the detailed design work was done by people he recruited.

"PJ Farmer joined in 1946, and established a mechanical workshop. He became Principal of Systems. I was fortunate to meet Tommy Gold, who had worked on radar in the Admiralty. We had got pulses circulating by mid-January 1947. Tommy Gold introduced me to Renwick, who joined us in March 1947."

Wilkes continued, "Renwick built up the machine and made it work as a whole. As time went on, I did less design and testing, and the whole responsibility fell on Renwick. Then on 6 May 1949, the machine suddenly did a calculation, of a table of squares."

From this point the emphasis switched from basic development to the provision of a service. "Edsac affected a very large number of users. There was always the idea that it should be a workhorse, and not just used for one or two big problems. So we made it available to laboratory research students from all departments at the university. They had to do their own programming. There was no positive selling: we let them find out about the computer for themselves, usually from their juniors."

David Hartley, who made a presentation covering the service provided by the Cambridge Laboratory over the entire half century since 1949, pointed out what a difference Edsac made. "It was 1500 times faster than the previous manual computational methods", which as he said was the biggest improvement ever made. Its actual speed was 300 instructions per second, and the user base numbered about 50.

Still, it soon became obvious that Edsac was only the start, and that a new machine incorporating the latest technology plus some new ideas that arose out of experience would offer substantially greater performance. Design work on Edsac 2 started in earnest as early as 1953.

The major significance of this machine, said Wilkes, was that "It showed that microprogramming was a viable system on which to base a major machine, despite the use of vacuum tubes. It was not easy to make a read-only memory out of vacuum tubes."

Indeed, "The Edsac 2 control matrix in which the microprogramming was stored was based on 8mm cores, which were very hot. Had transistors not come along I think microprogramming might have been stillborn. Everything was controlled from the microprogram, even the sequencing of operations in the core memory."

Another less well-known claim to fame for this second Cambridge machine was that "We were also a pioneer of bit-slicing. The word length was 40 bits, and we built 40 chassis, each containing one flip-flop and one stage of the adder. It made maintenance very easy. That idea was re-invented for the 2900 series MSI chips."

Memory was once again a major problem during the design stage. "There was an advanced Williams tube by then, but I was reluctant to get involved... Fortunately magnetic cores came along. We had contemplated a mercury memory with 40 tanks."

Wilkes continued, "Edsac 2 had a memory of 1000 40-bit words, twice the capacity of Edsac 1. As time went on, it seemed woefully insufficient. There were just not enough bits in an address to address more than 1000 words. So I dreamed up a system of indirect addressing, and Wheeler perfected and implemented it.

"In one of the first bits of computer industry PR, we called it 'main memory'. The old memory, which we called 'high-speed memory', was used for programs; in the main memory you could put numbers and program stacks. Most main memory accesses took two memory cycles. That gave an access time of six microseconds, twice that of the high speed memory. We bought it from Ampex. Capacity was 16K words."

Usage of computing facilities became more widespread during Edsac 2's time: David Hartley observed that it supported 200 users. The machine's speed he gave as 10,000 instructions per second, 40 times the speed of the earlier machine. Edsac 2 ran its last program in 1965 at what Hartley described as "the first official closing down ceremony, at which it played 'The Last Post'."

The story from there was taken up by Roger Needham, not in person as he was away in the United States on business, but via a video recording of his presentation at the Edsac 99 event.

By the early sixties Atlas, developed at Manchester and sold commercially by Ferranti, was setting the computing standards. "Everybody in the scientific community wanted an Atlas, but we couldn't afford one. A decision was taken with Ferranti to collaborate on producing a cost-reduced version of Atlas. This involved doing away with the paging system, and developing a different peripheral and memory organisation.

"Without the paging system we couldn't use the Atlas operating system, so jointly with Ferranti and its successor ICT we set off to design a new operating system from scratch." The resulting system, known as

Titan "was thrown open to all comers" in March 1967.

During the design stage the decision was taken to make Titan a timesharing system. According to Needham, "Maurice Wilkes went to the US and saw MIT's CCSS system, the first timesharing system, with Flexowriters as terminals. He came back with the strong conviction that this is what must be done at Cambridge."

According to David Hartley, "It had a pragmatic approach to resource sharing. It had non-interactive timesharing ('normal mode') as well as interactive timesharing ('expensive mode')."

Titan pioneered a number of new concepts. Roger Needham told the audience, "Our system was innovative in that it had a feature that restricted the use of a program as well as user access. This was not in Multics or Unix. That avoided a number of programs having system privileges when they didn't really need it.

"Within its limitations, that system ran the computer with amazing efficiency. None of us had any experience of multi-access systems. We originated the password file protection mechanism."

Cambridge decided to grasp the bull by the horns, and make the system available on a 24x7 basis on the outset. "That was no problem", said Needham nonchalantly, "and we never looked back".

Another pioneering aspect of Titan was the development of the BCPL programming language: Needham observed that "all the Xerox Parc software was written in BCPL initially". Robin Shirley pointed out from the audience that BCPL has an even greater claim to fame as the direct ancestor of C and C++.

David Hartley claimed that "Titan set many standards: some aspects laid the groundwork for the success of Unix." During its time the user base rose to 900: performance was now up to a quarter of a mips — 25 times as powerful as Edsac 2.

During Titan's lifetime, there were changes in the world outside Cambridge which had a large influence in the choice of the next machine. According to Roger Needham, "The IBM 360 became the *de facto* standard for scientific computing. That made it easy to swap data and programs. So you needed a 360/65."

In fact it was IBM's successor machine, the 370/165, which replaced Titan. It was installed at the end of 1971, and became operational in March 1972.

This first 'off-the-shelf' mainframe at the university was not entirely to the liking of a department used to designing systems with their own users' requirements in mind.

According to David Hartley, the 370/165 "was a most user-unfriendly system. TSO was incompatible with the batch job system; job entry was by punched cards.

"So we produced Phoenix, a user-oriented front-end language. That lasted through to the demise of the last mainframe in 1995."

This period, from the installation of the 370/165 to the arrival of the personal computer, was described by Hartley as "the Golden Age of the Computing Service". During it, the pioneering emphasis changed away from computer technology towards networking, as described to the Science Museum audience by Andy Hopper. Work on the Cambridge Ring started as early as 1974, before even embryonic PCs were available.

The Cambridge Ring "had repeaters, access boxes for device attachment, a 48 volt power supply converted to DC by repeaters, and 10 megabits per second speed. The maximum distance between the repeaters, which contained core memory, was 100 metres.

"That evolved into The Cambridge Distributed System. From the later seventies we had fibre links, the first and longest lived in the UK."

The arrival of the personal computer created problems for the Computing Service, as it did in installations everywhere. "We did not understand that microcomputers were real computers", admitted Hartley, bravely labelling his description of this 1982-87 period "Getting It Wrong".

"Getting It Right" is what has been happening since then. The major new development during this period was that "We explored the prospects of a city-wide network, and by 1992 that was in place. Most student rooms are wired up to Ethernet."

This is a succinct description of a quite radical departure. Cambridge University is scattered all over the city, and implementing a campus-wide network was a major logistical exercise involving the obtaining of wayleaves and the like as well as a massive financial investment.

The installation of the network was accompanied by the adoption of two new principles of operation by the Computing Service. First, that the job of the Service was to "operate a network and have full control over it", and second that the Service "should not own computers — users should do that".

So 50 years on we have the surprising situation that the University which pioneered the provision of a computing service has no computers of its own at all.

**Donations**

At the Society's Annual General Meeting in May, it was agreed that the Society should try for another year to subsist without imposing personal subscriptions, although further efforts would be made to attract additional corporate subscriptions. Since the Society's running costs are partly covered by a grant from the British Computer Society, it can be argued that those CCS members who are also members of the BCS are in effect already paying for a share of the work of the Computer Conservation Society through their annual subscriptions to the parent organisation.

Those who are not members of the BCS are therefore invited to consider making voluntary donations to help cover the costs. (These consist chiefly of the costs of publication and postage.) Cheques should be made payable to The Computer Conservation Society, and should be sent to:

The Treasurer
The Computer Conservation Society
31 The High Street
Farnborough Village
Orpington
Kent BR6 7BQ.

# BTM's First Steps Into Computing

*Raymond 'Dickie' Bird*

British Tabulating Machine Company (BTM) was one of the two dominant players in the UK punched card industry before the arrival of the computer. This article tells how the company entered the computer industry itself, and gives the designer's view of the development of the range of HEC (Hollerith Electronic Computer) machines.

BTM first became concerned about the threat to its business from the emerging computer when IBM developed a product called the CPC (Card Programmed Calculator). It sold well: they'd delivered 60 of them by 1951. But BTM had time to react because the CPC could not handle sterling arithmetic. I often wonder how the British computer industry would have developed if Britain had not had £sd currency: perhaps the 1900/2900 would never have got off the ground, and we would have been buying all our computers from the Americans much earlier.

BTM's first step was to recruit a man called Womersley from the National Physical Laboratory (NPL). He was an entrepreneur with great powers of encouragement and motivation, who had organised NPL's first computer development, the Pilot ACE.

Womersley showed great commonsense in realising that other computers under development in universities all over the world for scientific purposes would be too big and too expensive for commercial use. The technology was inappropriate, too: they had cathode ray tubes and mercury delay lines, and anybody who had seen a mercury delay line knew that it was not the sort of thing to put in a customer's office.

For design expertise, Womersley turned to Andrew Booth, lecturer at Birkbeck College, London, who had designed a very small machine called APE(X)C, which had been influenced by what he had seen during a two year stint in the US. Doc Booth was a mathematician by training, but he turned himself into one of the best engineers I have ever known. If somebody else could do something for twopence, he could do it for a penny. Just the person we needed to develop good small reliable machines.

So Bill Davis, Dickie Cox and I were sent off to a rotting barn in a village called Fenny Compton where Doc Booth was developing the prototype of his APE(X)C machine.

Not only was the barn rotting, it was as cold as the Arctic. Doc Booth's father was extremely parsimonious and objected to us using an electric fire, so in the night he used to cut one of the bars. The first job each morning was to wire it in again.

Eventually we finished copying the plans of the machine, returned to base at Icknield Way, Letchworth and built an example of it, which we called HEC 1. It was wired up solid: Booth didn't believe in plugs and sockets. How right he was!

The machine was built with simple circuits, ex-Government valves called 6J6s which were B7G-based double triodes. You could buy them in cases of 100 from Gower Street: they were built by the million, which made them reliable.

That's a point that many of the people who built early computers never grasped — that reliability came with manufacturing in quantity. The early computer engineers invented all sorts of ingenious devices — circuits which counted up to 10, that sort of thing — but they never worked well because nobody was making them in volume. But that's a personal hobby horse.

I was assigned to Billy Woods-Hill's lab, which was not very large, about 20' long. There was a bench along it, and he got a bit of chalk and marked off 8' of it for me, which I thought at the time was pretty mean. But when you consider he had four other people in there to develop multipliers, which became the BTM Calculators — the 541, 542, 550 and 555 — it wasn't really so ungenerous.

Woods-Hill's group comprised Lorin Knight, Alec Trussell, Dickie Cox and Martin Circuit. They were a good group, and we got on very well with them. Billy Woods-Hill and I had both been RAF officers, and so we thought alike, along the lines of 'When can we get down to the pub?'.

It was a good time. We were the only people who thought we knew what computing was about, and the rest certainly didn't have any idea. BTM desperately wanted the machine, and so placed unlimited faith in us: our brief was simply to get on with it. If I wanted something, there was never any quibbling: the money was always found. I must hand it to Cyril Holland-Martin, in particular, for ensuring that funding was always there.

Later we moved to Number Three factory, still in Letchworth, where the development people worked under Holland-Martin and Doc Keen, a brilliant electro-mechanical engineer who was largely responsible for the successful design of the Turing Bombe machines used to such good effect at Bletchley Park during the war. Keen was hostile: he spread rumours that if a lorry went by all the valves would fall out. He was nearly right, but not quite! His attitude to his staff was "Don't you go and look at those electronics folks, they're poison, you'll get some infection". They used to creep surreptitiously into the lab to find out what we were up to: we'd tell them and they'd sidle out again.

After we developed the prototype HEC 1, the next step was to link it to a tabulator. Now tabulators are synchronous devices, so if you stopped one you could only restart it at the first point in a revolution or cycle. This is no good for a computer, because calculations take a variable time; it reads in a card, then calculates away, then requires another card, then calculates for a different length of time, and so on.

BTM had produced a tabulator called the E6/6, which had a multipoint clutch. This consisted of a toothed gear wheel and an iron bar that dropped into it and clutched, so starting a cycle. We adapted this tabulator for the HEC 1. The men who did that were Steve Hare and another chap, Cyril Mead, who was extremely good at converting things and joining them onto things.

Mead was a super chap to deal with. You went to him and said, "I want a row of relays there, to read all those cards, and I want it to drop off at this and to pick up at that, and by the way I want to sense that hole", and he did all of those things efficiently and without fuss.

The HEC 1 had a very small drum — 16 tracks of 16 words, so a 256 word capacity. The drum was about an inch wide and five and a half inches in diameter, and ran at about 3000 rpm. This was another brilliant piece of work by Booth.

It was the things Booth didn't do that were also so very good. He timed everything from the drum, so if the drum ran fast or slow the machine kept pace with it. You didn't have a separate oscillator as many computers did, which needed buffers to keep everything synchronised.

The drum had a clock track, and relays to control head access to the tracks. There was a counter for registering the location of a record as indicated by the clock track, followed by another for recording the word address within the track. So when you wanted to retrieve data from the drum, you entered the word address, set the head relays moving, and when the clock track counter registered the same number as the address, you'd found your record.

Data could be written to the drum either from the arithmetic unit or from the control register, which was where you stored the instruction. An instruction consisted of track and word for the operand; a counter called C6 for shifting, multiplier timing or anything else you wished to count; the location of the next instruction; and the function — add, subtract, multiply, divide, shift, print, write, or test.

The 'test' function was what made the computer what it was. Calculators could test, and even tabulators could test up to a point, but nothing like so thoroughly as computers. Effectively, any sort of decision could be made by performing a series of tests.

The HEC 1 had two registers — an accumulator and a multiplier register. They were cunningly arranged to allow you to perform a double length multiplication. As you repeatedly added the multiplicand to the product, it got longer while the multiplier got shorter, until at the end of the calculation it had diminished to zero. This allowed the product to fill the accumulator and then continue into the multiplier register.

Then we were joined by an actuary! Ronnie Michaelson was taken on by BTM because the Planning Division as it then existed under Kenneth Elbourne wouldn't have anything to do with computers. Ronnie was a highly intelligent man, and he became effectively the planning and programming man.

He absorbed what I was doing like a sponge, and he used to make valuable suggestions about how the commercial world would react. For example, that we had to be able to read sterling — £sd. Our initial reaction was 'we can't do this, it will foul up the machine', but we quickly realised we had to work out how to do it.

It soon became obvious that everybody in the universities and other computer development labs were thinking about what the *computer* could do: how quickly it could calculate, how much storage it had and so on. But what really mattered in the commercial world was getting the information in and out. That had to dominate what went on inside.

So the questions that really mattered were: How fast can you read the cards? How many columns do you want to read? What code is it going to be in? How many print wheels do you want to use? Is it sterling or decimal?

The internals of the computer naturally mattered, but they had to be tailored to these requirements. Most of our development work was aimed not at making the computer a better calculator, but at making it better at getting data in and out. The preoccupation with that (and with cost and reliability) was the difference between the commercial world and the university chaps.

The chronology of all this is that I joined BTM on 1 January 1951, shivered in Booth's barn copying his plans during March of that year, and had built the prototype and got it to work by the end of 1951.

At this point the company decided that we had to exhibit our machine, to demonstrate to customers that we actually had a computer. So I was told to build one fit for display. The prototype was just wires going everywhere and held together by anything that came to hand. It worked, but it wasn't fit to be seen in public!

So we made an exhibition version, which became known as HEC 2. It essentially comprised four Post Office racks. They were a standard size, bolted together from shelves and girders with holes all the way down. They had covered power supplies at one end — if you put your foot on the cover the power supplies shorted and there was a bright flash! We did exactly that in the middle of the Business Efficiency Exhibition!

That was at Olympia, in 1953. When we got the machine there, of course it didn't run. We had to get it working, but Olympia then was riddled with electricians, all unionised up to the eyeballs. You couldn't do anything — you couldn't switch the machine on, you couldn't even put lights on or off!

So it took us all night to get the machine to work. That produced a dirty great row with the electricians, who got double overtime for staying all night — our Publicity Manager, Arthur Colton, was only able to persuade them to stay on at an exorbitant price.

During this night session, the huge Olympia dome was as black as pitch apart from the lights on our stand and one other pool of light a long way off. So I walked towards the source of the light, and who should it be but Powers Samas! They were trying to get the EMP (Electronic Multiplying Punch) going.

At the exhibition we demonstrated some simple commercial programs, and also noughts and crosses and bridge. The noughts and crosses display, which Cyril Mead designed, worked absolutely beautifully — until some schoolchildren came along and pressed all the buttons at once!

Ronnie Michaelson programmed the machine to bid a hand of bridge using the Acol bidding convention. You chose your hand, fed it into the machine, and out came the bid.

Then our Publicity man arrived, saying “I’ve got a calculating genius here who thinks he can calculate quicker than the computer can”. We said “Nonsense”, but we should have known better. This chap could multiply eight decimal digits by eight decimal digits in his head.

We decided to set up a scheme to test him. We positioned the chap next to a girl with a hand punch card machine, and somebody read out the numbers, and while the girl was still punching the genius said, “The answer is...”. One should really not be too proud, there will always be bloody something, as Peter Ellis used to say. He had a paperweight with that aphorism engraved on the bottom of it.

On HEC 2 drum memory capacity had gone up to 512 words (or 32 tracks). Many prospects felt that this was not enough for commercial computing work, and it wasn’t: it just couldn’t handle the input and output. So we decided to modify it for the scientific computing market.

The result was the HEC 2M. It used the chassis designed for the 541 calculator, a design that was riddled with plugs and sockets. Wires connected the bases to the components, linked the components themselves, and then connected the components to the plugs and sockets. So there were three times as many soldered joints as on the HEC 1.

Booth took one look at it and forecast that it would be “bloody unreliable”. He was absolutely right, but we had no option. The HEC 2M looked much more like a traditional BTM Hollerith machine.

We delivered about seven or eight HEC 2M systems. Customers included GE Research Laboratories (Graham Morris sold that one), Thorn, Esso, Boscombe Down, ARA and RAE, Bedford (they had two for wind tunnel applications) and the Indian Mathematical Institute. We believe that one was whisked off to the Soviet Union — we certainly never saw it again.

I remember being summoned to Esso’s site at Fawley because theirs wouldn’t work. It had an intermittent fault which I couldn’t understand — it didn’t read the first card in properly, though after that it worked perfectly. It took a field engineer of the old school to sort that one out. He went straight to the relay sensor, took out the armature, looked underneath it and found a little spot of grease. This was preventing the armature from actuating properly the first time it tried to move, though once it got going it was all right. There we had been, sweating away for hours, and he just came along with a piece of cloth and fixed the problem straightaway!

We had a very good patent manager called Aldred Bowyer who was very supportive. He came round regularly asking for patents: over my time at BTM I provided him with 27, which sounds very impressive. Looking back, I can see that most of them were trivial, but at the time I was thrilled by the glory of all this innovation.

One day I asked Aldred, "We've patented all these things, but we haven't had any royalties from anybody. Why not?". His response was, "It's not like that, lad. There's IBM over there, patenting like fury, and there's me over here, patenting like fury, and I meet with their patent manager, and we stack patents up in front of each other, measure how high they are, and if they're roughly equal, we cross-license". So the requirement was to get as many patents as possible. Aldred's response deflated me somewhat, which wasn't a bad thing for a cocky young bloke.

Our next development was a machine for commercial applications, essentially a HEC 2 with a number of enhancements specifically designed for a commercial workload. This became known initially as the HEC 4, and later as the 1201.

It had four registers instead of two. This allowed you to convert from either decimal or sterling to binary as the data was input from cards, a process impossible with just two registers. It had both a multiplier and a divider, operating in binary.

Once processing was finished, you naturally needed to convert out of binary, into what we called 'binny-10' or 'binny-sterling' depending on the requirement. So a special box was designed for that job.

To allow simultaneous printing and calculation, we included a print buffer — certain tracks on the drum reserved for storage of printer data. The drum capacity was increased to 1024 words at this stage: later, on the successor 1202, it was quadrupled to 4096 words.

We sold, or at least we delivered, 125 1201s and 1202s. That was more than all the other contemporary British computers put together, so it was a significant achievement.

To finish on a sad note, the recent death of Harold Ashforth, BTM's first programmer, means that all of the people involved on both the 500-series Calculators and the HEC computers have now gone except Lorin Knight and myself.

*Editor's note: this is an edited version of a talk given by Dr Bird to the Punched Card Reunion at Stevenage on 6 October 1998.*

## Getting Stevenage up to Speed

*Mike Forrest*

In the run up to development of the 1900 series I had visited RCA at West Palm Beach to explore RCA's introduction of "The Standard Interface" on a machine that ICT might sell as a successor to the very successful 1301/1500. This was the putative 2201.

My strongest memories of that particular spell in the US are of other aspects of technology than processors, particularly the Bryant Fixed Disc and the Electra turbo-prop plane.

The Bryant, which stored less data that you can get today on a Zip disc cartridge but weighed several tons, was hung about with awful warnings as to what would happen if things went wrong. They frequently did. We used to leave it running on test overnight in perpetual anticipation that next morning we would find it had seized up, or broken loose, or both.

The other technological memory is of flying between Philadelphia and Miami on Electra turbo-props. The seat rows level with the propellors tended to be empty, because there had been instances of blades coming off and spearing passengers in the cabin. There was always room there to lie across the seats.

This visit to West Palm Beach was in March and April 1963. Later that year I became acting head of what was eventually called, rather grandly, Computer Division of Data Processing Equipment Group. It had a sister division concerned with peripherals, headed by Brian Maudsley. Brian and I both reported to 'Echo' Organ, who thus became my seventh boss in as many years (the first, who had recruited me, left before I arrived, while his successor only survived a few weeks after I joined).

In the run up to the 1900 development programme, Stevenage had been involved with a version of the 1300 series fitted with the ICT Standard Interface for peripherals (it should really be called the ICT/RCA Standard Interface). This version of the 1301, known as the 1302, as well as being a deliverable product, formed an extremely valuable testbed for the interface's subsequent application to the whole 1900 series, where it was a distinguishing hallmark of the range.

My perception is that the Standard Interface represented an important step forward in the industry, and can be seen as the precursor of the more famous OSI seven layer communications standards. Certainly it has its place in the distinguished line of ideas whose development and application pioneered the move towards portability, culminating in Unix and, more by accident than design, the compatible PC.

Whatever its historical significance, the ICT Standard Interface certainly allowed the development at reasonable cost of a range of peripherals whose extent was an important strength of the 1900 series. Indeed, the very number of different peripherals became something of a burden.

When the order book for the early 1902 and 1903 deliveries started to build up, it soon became clear that every configuration was different. The most exotic ones always seemed to be for delivery somewhere thousands of miles away — Brisbane was a favourite.

Stevenage was allocated the development of the 1902 and 1903, the small processors in the range. The 1900 series was to be order code compatible from top to bottom, and the medium of compatibility was the Executive. It would, I think, be fair to say that this was the time when software overtook hardware as the real focus of innovation in the development of computer systems.

It was also the stage when hardware engineers made a personal transition to the realities of the modern world. Before then, they invented clever circuits with expensive profligacy. The advent of software and thus of the programming hordes demonstrated that there was a much more fertile field for spending money in great quantities than we hardware electronic engineers had ever found!

As a result, it became imperative that hardware be more standardised, to avoid the cost of software drowning the forward march of computing. It is interesting to realise now that at this time the cost of a unit of hardware capability was not falling year on year, in the way that happened with the advent of integrated circuits.

I remember proving conclusively that we could not afford to build circuits in a standard manner because of the redundancy that would be involved by not using all the inputs on a gate circuit in each of its instantiations.

One suggestion was that prototypes and early production models would be built with all gate inputs populated by components: when the design settled down the redundant diodes and other components on unused gate inputs would be omitted. Fortunately the prospect of logistics cock-ups was averted when this misplaced application of ingenuity was killed by common sense!

But the software people, who always seemed to be paid more, soon showed that their costs swamped those of the hardware people. So it became the role of the hardware engineers to make it easier for the programmers. Sometimes we hardware people wondered why the software specialists did not try harder to make it easier for themselves.

The other thing that forced hardware standardisation was the need for increased reliability. Only circuits used many times in a product could have the exposure during development to ensure this.

A crucial reason why the 1902/1903 activity got off to such a flying start was the existence of the ex-EMI team (most of whom had worked on the EMI4 which had just been dropped). They were very skilled at working together. Indeed, I felt a stranger in my own shop sometimes, coming as I did from the "old" part of the Stevenage foundation, so dominant were the ex-EMI engineers. When I later moved to the software division at Bracknell I again felt a stranger in my own shop, till I realised that I needed to grow my hair about a foot longer not to be thought to be a visitor!

Another factor contributing to the speed of ramp-up on 1900 at Stevenage was the manner of the announcement. As I said earlier, there were two development divisions at the time — Computers and Peripherals. About 200 people from those divisions, including the teams working on the PF182 and PF183 processors, were called into the canteen at the end of an afternoon and told there and then that ICT would do the 1900 as a series, that it would have the Standard Interface, and that Stevenage would do the "conventional" peripherals and the 1902 and 1903 (and by implication, later the 1901).

Echo Organ took only about five minutes to say this, and then said to Brian Maudsley, Bill Talbot and me (who were standing beside him) that it was up to us to get on with it fast.

Even at this early stage, therefore, two key elements were already rigorously technically defined — the Standard Interface, and the order code of the processors (by virtue of the prior existence of the FP1600/1900). In addition, the family of logic circuit cards to be used already existed in the FP1600. I may be wrong, but I cannot recollect designing a single further circuit for use in the processor logic.

In retrospect it is clear that these factors short-circuited the usual (characteristically British) tendency to argue with everything and to seek to reinvent everything in their own image. Instead, the task became at a stroke that of turning rules into an implementation, and having that running and manufacturable in record time.

I have ever since believed that having plenty of time to do something is the enemy of getting it done. A similar analysis can be made to account for the IBM 360 getting done. A "realistic" prior estimate of a complex project will ensure either that it is never started or that it overruns catastrophically (because it will be seen in the early stages to leave time for "optimisation", which often means conflicting approaches and vacillation).

The kick-off experience also demonstrated to me the validity of Cardinal Newman's remark that

"Deductions have no power of persuasion
Men will live and die upon a dogma".

Our dogma was that we had 12 months to demonstrate that we could play our part in a development that it was clear the company was being bet on.

Nevertheless, for me personally it seems little short of a miracle that the 1902 and 1903 got done. At the start I did not believe it would happen. But the team working on it seemed confident, so I came to believe it too.

There was a crucial stage when we started attaching the peripherals. This led to fierce battles between the two local divisions, with each believing, when the products did not work correctly together, that the other was at fault. The saving grace proved to be that the 1302 was standing there and working. It became the definition of the Standard Interface: if a peripheral worked on the 1302, then that peripheral was by definition "right", and conversely.

Brian Maudsley and I had offices between which was sandwiched a common secretary's office, into which they both opened. Maybe the real credit for war not breaking out should go to the occupant of that office, Daphne Normandale.

Just as the 1302 became the definition of the Standard Interface, so the 1904/1905 (ie the FP6000) became the definition for the processors. If a "user level" program executed on that, it was imperative that it also executed correctly on the 1902/1903. If it didn't, the 1902/1903 had to be changed so that it did.

The Executive provided the practical medium in which to incorporate changes to bring this about. It was clear even at the time that the amount of changes required to the back-wiring (that is, to the electronically implemented logic) as we went along was a great deal less than for earlier systems that did not have this developed concept of an Executive.

These precepts formed the bedrock of the work at Stevenage. Some in the early stages bemoaned the lack of freedom to try their own ideas when they conflicted with the precepts. This was understandable: they had been highly innovative in the past, and part of the early traditions of the computer industry everywhere was to make as many different machines as could be conceived.

These frustrations gradually disappeared, but the sheer momentum of the work became nerve racking. Much of what would now be called the "intellectual property value" rested in the Executive, which was kept on paper tape. Paper tape is notorious for its tendency to snarl up. It was not the most familiar medium at Stevenage either, as the site had been nurtured on punched cards.

A competition between the hazards and adverse consequences of dropping a deck of cards and of snagging a reel of paper tape would be a close run thing. A lot of anguish and not a little righteous anger surrounded accidents with both. Woe betide a visitor (or manager!) who intruded into an Executive testing session and, trying to be helpful, became party to such an accident. Or, even worse, pocketed some paper tape as a souvenir.

One of the more interesting and fraught areas was magnetic tape. The transports that ICT was using on the small 1900s came from several sources. One was American (Potter) and another French. A common element was that our contacts in both suppliers tended to be oversized personalities.

I recollect a trip with Arthur Humphreys to Potter's factory in Puerto Rico via New York, which was Potter's base. The Potter sales director accompanying Arthur spent most of the flight sitting on the arm of Arthur's first class seat, making the journey excruciatingly uncomfortable for both of them.

The French tape deck supplier was, rather confusingly, known as CDC, which stood in this instance for Compagnie des Compteurs. Even more confusingly, *un compteur* is a water or electricity meter, not a computer. CDC made these as well as tape decks for *ordinateurs*.

We had problems with some of our home grown peripherals, especially card readers. There were two varieties of these, the photo-cell reading electronics of which I had had the misfortune to have designed personally.

But the CDC tape decks excelled everything in their ability to go haywire.

They had mechanical rather than vacuum tube tape buffers, with all the opportunity that presented for tape maltreatment. It was no great challenge to write a sort program that would hit a resonance with spectacular results. But our contact at CDC, Oscar Cytrin, was charm personified.

I mention this matter of magnetic tape to emphasise just how large a proportion of effort and anguish was associated with mechanisms rather than electronics and software. In retrospect, I am sure that the peripherals occupied the greater proportion of my time, even though I was officially only in charge of the processor division. But perhaps this was because the processor people made sure I was sufficiently occupied to keep out of their way while they got on with the real work!

After the peripherals, the core store was the most marginal, and therefore troublesome, element in the system. There were two speeds — six microseconds and two microseconds. The faster was the more reliable, which demonstrated the importance of good engineering design.

A little light arithmetic shows that every word weighed about 15 grams. In today's memory modules you get about 1000 words for every gram.

At this distance in time it is not easy to discern the shape of the day to day activities, but the decision to exhibit at the Business Efficiency Exhibition at Olympia served a crucial role in pacing the operation. I suspect that without it, the Stevenage product — both processors and peripherals — would have reached customers' offices at least six months later. Such is the power of the absolute deadline.

The decision to exhibit was not as sharp as that which was made to begin the overall endeavour. There were those who thought it would divert attention from the development itself. Others feared it would make the problems of sustaining revenue from older products before 1900 deliveries built up even more difficult. My view on this last point is that many more businesses sink because they are undermined by new products from competitors than ever founder because of competition from their own offerings.

Once the decision was taken, the couple of months before the exhibition seemed somehow unreal. All I can remember are vignettes of bizarre hours worked. I do remember moving from my home in Ashwell — only about 15 miles from Stevenage — into a hotel in Stevenage itself, so as to be closer at hand in the middle of the night. I can't remember if I did this because my wife was complaining at my odd hours: if so she must have given up on that soon afterwards.

I do remember that Stevenage still had a manual public phone exchange at the time. To make it possible for me to be called in (no pagers or mobile phones then), one of the hotel's few outside lines was plugged directly to my bedroom.

During my first night at the hotel, the people working on the machines felt that my greatest contribution would be to keep away, so they did not call me out. But I had taken five bookings for the hotel by the time its staff came on duty next morning!

The prototype 1903 was duly exhibited at Olympia, and the show was judged a massive success for the 1900 series as a whole. Contrary to some subsequent stories, what was demonstrated was largely real — there was little manual twisting of tape reels from behind by hidden hands.

One story was true, though. Only a few days before the machine was shipped to the exhibition, the core store of the 1903 was lifted into the processor frame from the floor where it sat for many previous months. The frame collapsed under the unaccustomed weight!

Returning to the peripherals, there was an elaborate schedule specifying which devices should have been tested on the 1902/1903 by which dates, and we had to report on progress against this schedule weekly. The information went from Stevenage to the planners (who were I think based at Kenton), where it was incorporated into a consolidated report (and then appeared to go to a whole army of internal critics).

I starkly remember the planners' ability to make it appear that no deadline was ever quite met. I equally remember, and I hope they do too because they were meant to, my determination they should recognise that it was easier to report the work of others than to do it oneself.

Maybe the whole thing was a piece of planned abrasive friction to motivate everyone. When I later became a planner, the goodies and baddies of course seemed miraculously to have changed places!

There were genuine difficulties with the peripherals. They contained a wealth of special circuits to drive solenoids and suchlike. These were not always so well shaken down by replicated use as the processor electronics.

They also pushed the contemporary generation of semiconductors very hard. The printer hammer drivers had to deliver quite a few amps into the solenoids. And the physical media involved — especially the older kinds like punched cards — were being moved around at speeds which in retrospect can be seen to be the end of their evolutionary performance development. There is nothing quite like a good high speed card reader jam or spill to teach the rudiments of self-control and the malevolence of inanimate objects.

Another irritation was that the peripherals were always in the way, being bulky and well provided with sharp corners.

Naturally the Olympia exhibition was not the end of the task. We had to establish production as well as build a couple of prototypes. In many ways that proved the harder task.

The later market history of the 1900 series was impressive. But there was a sting in the tail for me. I had moved from Stevenage to the Sales Department, and was selling 1900s to universities and research organisations, competing against English Electric's System 4.

Later, after another move, this time to Planning, and after the formation of ICL, I visited a research organisation to which I had earlier lost the order to a System 4. The customer, having had problems with the machine, roundly berated me for being such a poor salesman as to have failed to persuade him to buy a 1900 which, he now recognised, would have been a much better choice. So his problems were the System 4 were all my fault too!

The danger of retrospection is that it seldom does justice to individuals. This article has certainly not done so. But to mention individual names risks making hurtful and unjust omissions. I must however mention two who are no longer alive — Ron Feather and Bill Talbot.

It is often not those who are noisiest at the time who are the most deserving of credit. It may be that those who most stoically accepted that what had to be done was essentially a challenging implementation task rather than an opportunity for innovation made some of the greatest contributions simply by not rocking the boat.

To those who did this, I would dedicate this thought: "In this business you can either make things happen, or take the credit for it, but not both".

*Editor's note: this is an edited version of the talk given by the author to the Society during the ICT/ICL 1900 seminar at the Science Museum in May 1996.*

## Obituary: Charlie Portman

*Chris Burton*

One of our industry's most inspiring engineers, ECP Portman (known to everyone as Charlie) died on 19 December 1998 five weeks after his 65th birthday and on the threshold of his retirement from ICL.

Charlie graduated in Electronic Engineering from the University of Liverpool and joined the Ferranti Computer Department in the Magnetic Drum Laboratory in 1954. He was soon involved with the new Mercury and Sirius computers, where he first showed his grasp of overall system engineering.

In 1960 he became part of the Orion 1 design team, where his clear understanding of the interaction of software, hardware and a desired system specification could be brought to bear on the pioneering work of multi-programmming. Charlie took the first (unfinished) Orion to AB Turitz in Gothenburg and there completed the hardware and software so that it was accepted by the customer. This was a major manifestation of his skill in motivating staff of different disciplines to achieve a goal in difficult circumstances.

As the best system engineer in West Gorton he led all the new 1900 series hardware development there, and also participated in product planning for these larger systems. Once the hardware designs were established, he took on responsibility for all hardware-oriented software for large systems, that is test software, executive-type software and design automation. He then carried this work through into the corresponding support for the early large-scale 2900 series machines.

Charlie then turned towards advanced developments, particularly the exploitation of the falling costs and proliferation of silicon technology, the architecture of very large systems, and the role of federated and networked systems, when all these ideas were in their infancy. Charlie was appointed an ICL Fellow in 1997, and was awarded a Chairman's Medal in 1998.

In the last few years he had taken an active role in the affairs of our Society, leading the Manchester Pegasus Working Party, and playing a key role in the SSEM Rebuild team. He had further ambitions for the CCS in his retirement, which now tragically he has been denied. His very many friends and colleagues will miss his warmth and wise counsel.

## Letters to the Editor

Dear Nicholas,

In his interesting article on the ICT 1301 series Hamish Carmichael comments on the Powers Samas plans to sell a Ferranti machine named Pluto. This was indeed a Pegasus and was the elder twin of the machine now at the Science Museum; both machines had extra character handling instructions and additional store of 336 bit delay lines, but they preceded Pegasus 2. Pluto itself was set up at Whyteleafe in Surrey where Powers connected their own latest card equipment, including interstage punching, and the ambitious Samastronic printer. Problems with the Samastronic delayed commissioning but Pluto itself was later delivered to the London and Manchester Assurance Company.

Hamish also refers to the 'Manchester Autocode' on the 1301, and this was apprently based on the system written at Manchester University and widely known as Mercury Autocode — it was no doubt renamed for the 1301 because Mercury was then a competitor's machine. Pegasus Autocode was different, being based on Tony Brooker's earlier system on the Manchester Mark I.

Yours sincerely,

Derek Milledge
Bracknell, Berkshire
21 March 1999

Dear Mr Enticknap,

I read with interest the article on the Ferranti Argus in the last edition of *Resurrection*. In 1994 I took a tour of the Hartlepool Nuclear Electric plant, where the computer room was proudly on display. You may well imagine my surprise to see Ferranti logos on the equipment, and further enquiry with the guide alleged the machines to be Argus computers of 22 year vintage. She was however keen to stress that the machines still delivered the reliability they required, and that there were no plans for replacement.

Yours faithfully,

Adrian Cornforth
Rochdale
27 January 1999

To the Editor,

It was a delightful prod to the memory to read the piece by Stewart Hine. I was one of the apprentices drafted in by Ron Clayden to work on the pilot machine in 1954 at the ripe old age of 18. I wonder how many of your readers of that era are still active in computer circuit design? As Chairman of Mosaid Technologies in Canada I am still reasonably current on circuit issues as they relate to 256M memory chips. A far cry from the drum I too remember!

I too can claim that the experience stood me in good stead. The "Margin Test" technique was the inspiration for the first paper I gave on a memory chip (at the 1975 ISSCC conference, on a marginally testable 4K DRAM). Many other links from all those years ago to more recent stuff can be found over the 45 years.

I think I can add to the 6F33 story. As a new division, we were chronically short of the most basic needs. Management was not amused when, on a senior level visit, we drew with chalk "Fire" (we were cold) and "cupboard" with a few bits scattered. Then an engineer was transferred to us from the Radio Altimeter group. He came with a *cupboard.* It was full of components, including boxes of 6F33s. The cupboard was coveted more than the parts, though I guess now that some 6F33s might have been retained. The suggestion was made to send them back to the Ministry, but it was immediately rejected on the grounds that they would then ask where the rest were!

The solution was to pile it all up on the floor and let it be known this was stuff no longer wanted. The apprentice locusts duly cleared up fast. Most of us (all I guess) were avid hobbyists.

The best legacy I received from my days at EMI was the best management training I could wish for. Avoiding the incredibly stupid practices observed daily and their catastrophic consequences for the company has been a beacon ever since. I subsequently made the effort to combine management studies (then part of Mechanical Engineering) at Newcastle while having the great good fortune to be tutored by one of the WWII greats in radar, FJU Ritson, an FC Williams co-worker (FCW was my PhD external examiner). All that happened after that is another story.

RC Foss
by e-mail from <foss@mosaid.com>
6 February 1999

## Preservation Policy Working Group

*Simon Lavington*

The Society is compiling an index of hardware, software and documentation from UK-designed computers of the period 1948-1970. A checklist of these machines is given below, from which it will be seen that analogue and non-stored program computers are excluded. The date shown is the approximate year of first operation or delivery.

Although very few pre-1970 computers still exist, it is believed that individuals and organisations have kept bits of hardware, manuals, program listings, peripherals and so on, which have now become of considerable historical interest.

The purpose of the CCS index is therefore to document the technical details and present location of all pre-1970 artefacts which could (by prior arrangement) be studied by *bona fide* researchers. A summary of the index will be made available electronically, though sensitive information such as private addresses would naturally not be publicised.

Individuals or organisations holding early computer artefacts are invited to contact me, by e-mail at <lavis@essex.ac.uk> or by phone or mail (see inside back cover).

### Checklist of pre-1970 UK-designed computers

| Machine | Year |
|---|---|
| Ace (NPL) | 1957 |
| AEI 1010 | 1960 |
| APE(X)C (Birkbeck) | 1952 |
| ARC (Birkbeck) | 1949 |
| BTM 1200 series | 1954 |
| BTM HEC | 1953 |
| Cadet (Harwell) | 1955 |
| Computer Technology Modular One | 1968 |
| Edsac (Cambridge) | 1949 |
| Edsac II (Cambridge) | 1957 |
| Digico Digiac | 1966 |
| Digico Micro 16 | 1968 |

| Machine | Year |
|---|---|
| Elliott 152, 153 | 1950? |
| Elliott 401 | 1953 |
| Elliott 402 | 1955 |
| Elliott 403 | 1957? |
| Elliott 405 | 1956? |
| Elliott 502 | 1961? |
| Elliott 503 | 1962? |
| Elliott 802 | 1958 |
| Elliott 803 | 1959 |
| Elliott 4100 series | 1966 |
| Elliott 900 series | 1966? |
| Elliott Nicholas | 1952 |
| EMI EBM | 1957 |
| Emidec 1100 | 1959 |
| Emidec 2400 | 1961 |
| English Electric Deuce series | 1955 |
| English Electric KDF6 | 1963 |
| English Electric KDF7 | 1965? |
| English Electric KDF8 | 1962? |
| English Electric KDF9 | 1963 |
| English Electric KDN2 | 1962 |
| English Electric KDP10 | 1961? |
| (English Electric System 4 (RCA Spectra) | 1968?) |
| Ferranti Apollo | 1961 |
| Ferranti Argus series | 1963? |
| Ferranti Atlas | 1962 |
| Ferranti Hermes | ???? |
| Ferranti Mark 1 | 1951 |
| Ferranti Mark 1* | 1953 |
| Ferranti Mercury | 1957 |
| Ferranti Newt | 1959 |
| Ferranti Orion | 1963 |
| Ferranti Pegasus | 1956 |
| Ferranti Perseus | 1959 |
| Ferranti Poseidon | 1962? |
| Ferranti Sirius | 1961 |
| GEC 90xx series | 1964 |
| GEC S7 | 1966 |

| Machine | Year |
|---|---|
| ICT 558 FCC | 1962 |
| ICT 1300 series | 1961 |
| (ICT 1500 (RCA 301) | 1963?) |
| (ICT 1600 (RCA 3301) | 1965?) |
| ICT 1900 series | 1965 |
| Leo | 1951 |
| Leo II | 1957 |
| Leo III | 1962 |
| Manchester experimental transistor computer | 1953 |
| Manchester Mark I | 1949 |
| Manchester Meg | 1954 |
| Manchester SSEM | 1948 |
| Marconi Arch 1000 | 1963 |
| Marconi TAC | 1961 |
| Marconi Myriad | 1963 |
| Metrovic MV950 | 1956 |
| Mosaic (MoS) | 1953 |
| Pilot Ace (NPL) | 1950 |
| RREAC (RRE) | 1961? |
| Smiths Seca | 1955? |
| SEC (Birkbeck) | 1950? |
| Stantec Zebra | 1958 |
| Titan (Cambridge) | 1963? |
| Treac (TRE) | 1953 |

**Recording of Personal Histories**

*Simon Lavington*

Many Society members and others have from time to time expressed a wish to help in recording the history of British computing. Hitherto it has been difficult to capitalise on this willingness. The Society is now interested in collecting the personal reminiscences of anyone who was involved in the design, production or use of pre-1970 UK computers, especially during the pre-1960 period. If you have anecdotes, please consider writing them down or making an audio cassette. The material will be placed in the CCS archives for consultation by researchers. Again please contact me for further information.

## Elliott 401 Working Party

*Chris Burton*

A little progress has been made with the power system, such as that the cooling fans have been brought up to speed. A small step, but it gives us confidence that the precautions we are taking with the old wiring insulation are worthwhile.

## Bombe Rebuild Project

*John Harper*

Our redrawing exercise is not quite complete but this no longer holds back the drawing activity in any way. We can now proceed as quickly as effort, resources and funds allow, with confidence, knowing that the remaining drawings have no impact on the parts we are currently manufacturing. The final drawing phase, which is mostly electrical, can now be completed in parallel with mechanical construction.

Progress on the physical aspects of the rebuild are proceeding slowly but surely, but again not all of this is visible at Bletchley Park. What can be seen, at the time of writing in early July, is that all four horizontal bars are complete and in place and the majority of front and rear plates are test fitted to these bars.

To the casual observer this may not look much, but to those involved this is a great relief because we have proved that nearly 1000 holes hand drilled and many of them tapped out with threads to take the fixing screws are all in the correct places. We have also proved that the front and rear plates made using Computer Aided Design techniques from our new drawings are correct. The fact that this whole assembly measuring around six feet by five feet fits squarely into our previously manufactured frame is a great consolation to those who have put in so much effort.

Not visible at Bletchley Park is the construction of other units. The hinged gate which carries the jacks into which the menu is plugged is nearing completion and should be fitted around early September. There are many other items on the go but the most impressive is the main gearbox casting which has now been successfully cast in high grade iron from modern patterns made from 3D files which a member of our team produced. Modern patterns were produced using the resources of the Rapid Prototyping Centre described in my last report in *Resurrection* issue 21. The casting is most impressive and weighs 41 lbs. We now need to find somebody to machine it!

Those interested in reading more about our project may visit our Web site at <www.jharper.demon.co.uk/bombel.htm>.

The project still needs a great deal of help and support as described in previous reports with the most immediate being to locate people with turning facilities. If you are able to help with this or any of the other activities mentioned in earlier reports please contact me by e-mail at <bombe@jharper.demon.co.uk> or by phone or mail (see inside back cover).

## Pegasus Working Party

*Len Hewitt*

Tha machine has worked well over the past few months. We have intermittent and permanent faults, but none very serious. We are still very short of spare 42- and 35-bit lines. If anybody out there has any T for torsional type lines around as souvenirs we would be prepared to swap a longer 360-bit line for a 42- or 35-bit 6T line.

The good news is that Pegasus is to move into the Computing Gallery at the Science Museum, possibly this summer, and will be set up as a working exhibit, with its working periods to be determined by the museum.

Pegasus has been running for several hours on a fortnightly basis at Blythe Road. Unfortunately it has not been posssible to have the "In steam" days as we had in the old Science Museum canteen, but it is hoped to arrange something similar when the move has taken place and the machine is working again.

**Simulators**

Simulators for a variety of historic computers, including Edsac, Elliott 903, Pegasus, the Manchester University Small-Scale Experimental Machine and Zebra, can be found at our FTP site. Access details are on page 36.

## Forthcoming Events

**21-22 August 1999, and fortnightly thereafter** Guided tours and exhibition at Bletchley Park, price £3.00, or £2.00 for concessions

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

**21 September 1999** North West Group meeting on "The Doomsday Project"

Speaker Professor Stephen Heppel

**13 October 1999** Afternoon seminar on "Punched Card Machines and Applications"

Speakers include John Bennett, Hamish Carmichael, Frank Tilley and Adrian Turner

**15 October 1999** Leo Society reunion

See News Round-up for details

**26 October 1999** North West Group meeting on "JANET"

Speaker David Hartley

**18 November 1999** Late afternoon talk on "Visible Record Computers"

Speaker Tony Sale

**23 November 1999** North West Group meeting on "The Acorn and BBC Computers"

Speaker Herman Hauser

**16 December 1999** Late afternoon talk on "Two early computers"

Speaker Professor Mannie Lehmann

The North West Group meetings will take place in the Conference room at the Manchester Museum of Science and Industry, starting at 1730; tea is served from 1700. The London meetings on 13 October and 16 December will take place in the Director's Suite at the Science Museum, and the talk on 18 November in the Museum's Lecture Theatre.

Queries about London meetings should be addressed to George Davis on 0181 681 7784, and about Manchester meetings to William Gunn on 01663 764997.

## FTP, Web and E-mail Addresses

The Society has its own World Wide Web (WWW) site: it is located at **http://www.cs.man.ac.uk/CCS/**. This is in addition to the FTP site at **ftp.cs.man.ac.uk/pub/CCS-Archive**. Our Web site includes information about the SSEM project as well as selected papers from *Resurrection*. Readers can download files, including the current and all past issues of *Resurrection* and simulators for historic machines.

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