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.

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

Resurrection

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Editorial

Nicholas Enticknap, Editor

The year 1994 was one of transition for the Society. The working party activity which started the Society off has virtually ceased because of major changes at the Science Museum, and the absence of regular scheduled meetings in London has made the year a very quiet one for those in the south.

As a result, this issue unusually contains only one article based on a Society meeting: a report on the debate on the success or failure of the British computer industry, starting on page 19. By way of consolation we carry an article submitted by Don Hunter on the Zebra: this was to have been the subject of a London meeting. Our third historical feature continues the drum theme that has permeated recent issues, being a report by John Bauldreay of his experiences at Powers Samas.

In the north, meanwhile, the picture in 1994 has been very different. The North West Group has had an active year of meetings as well as making progress in the restoration of the Manchester Pegasus. Inbetween London and Manchester there is a new focus of activity at Bletchley Park, where the Society has been displaying a computer exhibition since July. A description of the developing relationship between the Society and the Bletchley Park Trust can be found in Chris Burton's article on page 6, which also gives a vivid account of the Royal opening of the museum exhibitions there in July.

There have been changes on your Committee as well. Adrian Johnstone, who has chaired the DEC Working Party since the Society's formation, has had to relinquish this responsibility following promotion at work. Pat Woodroffe has decided to step down from the Committee altogether following a move to a new home.

Both have served as Committee members since the Society was formed in 1989. Both have also played a key role in bringing *Resurrection* to you: Adrian handled all the typesetting for the first four issues, and set a house style we still follow today, while Pat has laboured tirelessly in transcribing cassette tapes of our meetings, without which most of our issues would have been pitifully thin! So I am glad to take this opportunity of personally thanking both of them for their work on *Resurrection*, work which has been largely unseen by the membership but which should not go unacknowledged or unappreciated.

Guest Editorial

Andrew St Johnston

Probably the most interesting time of my life to *Resurrection* readers would concern the 401, as it is the prime subject of a resurrection. I hope that a full history of Elliott Bros activities will appear in due course.

The NRDC was making stalwart efforts to get computing off the ground in the UK, and gave Elliott's a study contract for a large computer based on the 152 with its plug-in units and parallel whiffle tree multiplier. It was wisely thought that a pilot model should be built to test the techniques which Bill Elliott's lab had developed over a period.

These included logic circuits desiged by Charles Owen for the 153, Bill's nickel delay line discoveries, and magnetic disc storage developed by Peter Atkinson under Robbie Robins, all using the 152 333Kc clock frequency. I was appointed Project Leader for the making of the Pilot model, which was to be at reasonable cost. One consequence of this requirement was the conversion of the Owen subminiature pentode logic circuitry to dual triodes, which Laurence Clarke of my team carried out. The internal NRDC job number for the work on the Pilot model was 401.

Previous Elliott designs were special purpose machines, but I had always been interested in general purpose computers. I had studied the literature, in particular a report on an American computing conference in the early fifties (could any reader who has a copy of this report please contact me!). There were papers in this conference document on single address, double address, three or four address and even three state logic circuitry.

Norman Hill's team was building a machine using the Owen circuitry, nominally to solve a particular calculation, but Nicholas was a general purpose machine which used long nickel delay lines as main memory and a single address order code. I opted for the magnetic drum type of main memory because it could be expanded more readily than the nickel delay lines.

I therefore chose a two address order code which by optimum programming (placement of the next instruction addresses carefully so that they became available in the next instruction access time) could provide fast calculation times. Nickel delay lines were used for registers.

At that time Elliott Brothers had an organisation hierarchy based on that of the GEC Research Labs, with departments for techniques such as electrical engineering, computing, and mechanical engineering, which shared a common drawing office and workshop. Fortunately each lab was allowed a local workshop staffed by skilled craftsmen. I was allowed to build the 401 in the local workshop, which cut out much bureaucracy but had the consequence that there were no drawings.

I designed the basic logic structure and much of the other parts, such as power supplies from a three phase mains, a monitor unit and the cooling system (I had suffered with the 152 from another department's attempts at cooling).

A mechanical engineer, Chris Phillips, was loaned to us: he had a pull in the central workshop, where the drum was made under the aegis of his designs. Harry Carpenter, my boss, made a tape reader out of a uniselector, and James Last put drive solenoids on an Olivetti electric typewriter.

Aiming at the Physical Society Exhibition of 1953, I think we designed and made the machine in well under a year. Laurence Clarke and Hugh Devonald cooperated in getting the machine going as a computer, Laurence being king of the multiplier which was beyond me.

Christopher Strachey made the exhibition a success. He wrote two programs, a prime number generator and a log calculation, and tested them using a simulator of the 401 order code running on the Manchester Madam (another NRDC project).

There were only a few days between the time when the 401 first worked as a computer and the day of the exhibition. Chris managed to get both programs going in those few days at Borehamwood. I always comment that the floor was covered with butt ends, but only two matches — he did take a lunch break!

The 401 was undoubtedly the first computer ever to be exhibited in public. It was not only exhibited: it worked. Indeed, Strachey's log print-out to 10 decimal places showed up errors in the long established public tables. I wish the Computer Conservation Society team every good luck in their efforts to restore the machine, and hope that the 401 goes on public display again one day... working!

Society News

Tony Sale, Secretary

There has been very little activity at the Science Museum in London, nor have we had a meetings programme since the debate in February. However your Committee has now appointed Chris Hipwell and George Davis to form a meetings programme sub-committee, with a brief to put together a programme for 1995. We will publish details of this programme shortly.

As reported elsewhere in this issue, Pegasus now has a new room constructed around it, and the Elliott Room at Blythe House is being laid out. These advances should allow working party activity to recommence at the Science Museum before much longer.

The Society's archive still gives cause for concern. The Science Museum is still setting up its document centre, and until that is operational the archive will remain inaccessible.

The work at Bletchley Park is now coming to fruition. The joint planning application for the whole of the Park has been agreed by the Park's present owners, British Telecom and Property Holdings, and the Bletchley Park Trust, and has been submitted for approval. This agreement has given the Trust 80% of what it wanted, and will allow museum provision to proceed as the Trust had planned. The application enables a value of the property to be transferred to be agreed between the present owners and the Trust. Completion of the purchase is set for April 1995.

The initial museum provision in H Block and Faulkner House has been very successful. The CCS computer exhbition continues to progress: the Elliott 803 is close to being operational, while other machines are in the process of restoration.

The Trust is applying for formal registration as a museum, which will increase the professional standing of the whole operation.

Contact point

Readers wishing to contact the Secretary are reminded that he is now running the secretariat from home. The secretarial telephone number is 0234 822788. Letters should be addressed to 15 Northampton Road, Bromham, Beds MK43 8QB.

Progress at Bletchley Park

Chris Burton

> Readers of *Resurrection* will be aware of the Society's increasing involvement with the plans to establish Bletchley Park as a centre for computing and cryptography museums. In this article committee member Chris Burton describes the significance of the Park as a historical centre; the circumstances of the Society's involvement; and the progress of the Bletchley Park Trust so far, culminating in the Royal Opening on 18 July 1994.

During World War 2, up to 12,000 people worked at Bletchley Park, 50 miles north of London, on top secret code-breaking work. Enemy radio messages were intercepted, the sophisticated encipherments broken, and the resulting information used to the Allies' advantage. The clever work was done by mathematicians (including Alan Turing) and linguists, while the bulk of the dreary routine work was done mostly by servicewomen.

A large special purpose electronic machine, Colossus, was installed there in 1943, followed later by 11 more. With hindsight, we would probably describe Colossus as a fixed-program electronic computer, in the same sense that Eniac was.

Despite the large number of people working there, their oath of secrecy prevented any information about what went on at Bletchley Park (known affectionately as "BP") leaking out until the mid 1970s. Then the existence of Colossus was revealed, but with little detail about the design or use of the machine. In subsequent years, a few fascinating books about BP have appeared, sometimes contradictory, and usually tantalisingly short of key details. There has until now been no memorial to all those people who worked tirelessly in spartan conditions, most of them not knowing what their fellows were doing, nor knowing the results of their own work.

About three years ago, the 57 acre park with its Mansion and many surviving wartime buildings was about to be sold off for housing development by its owners, British Telecom and Property Holdings (the agency which looks after Government buildings and land). Some wise people in the neighbourhood recognised the threat to what was potentially an important heritage site, and formed the Bletchley Park Trust. The Trust at once appealed for funds to try to preserve the site and the key historic buildings, and to prevent their demolition and the building of houses on the estate.

In order to pay for the property, the Trust plans to set up a number of museums — a "Museums Campus" — for the paying public, as well as leasing some of the postwar buildings as office and workshop space to paying tenants. Since the formation of the Trust, negotiations have continued with the owners for acquisition, but these have not yet reached a final conclusion.

Recently, however, a two year lease on one building was agreed, and permission to allow the public into the park granted. These arrangements allowed the Trust to put on Open Weekends for the public, giving them guided tours of the buildings and the opportunity to see various exhibitions relevant to the wartime work. At this stage, all the work is being done entirely by volunteers.

All this is highly relevant to the Computer Conservation Society. Our Secretary, Tony Sale, is one of the founders of the Trust and is its Museums Director. The plan is to establish separate museums of post-1930s technology, particularly for Cryptography, for Computing, for Radar and Electronics, and possibly for Telecommunications and for Air Traffic Control.

The museums will be housed in the numerous and spacious buildings. The whole park will have a 1940s theme against the background of the code-breaking work. The Museum of Computing will have adequate space for workshops and storage, and it is likely that much of the restoration activities of the CCS will take place there as well as in the existing science museums in London and Manchester.

It will take years to establish the museums, so in the meantime various exhibitions have been mounted for the public to see on the Open Weekends. Additionally, a start has been made on the construction of a working replica of Colossus. This is a matter of urgency because some of the designers and users are still alive, and their memories and experiences need to be tapped while this is still possible. At the end of the war, Churchill ordered that the 12 Colossi must be "broken into pieces no larger than a man's fist", and as far as we know, no significant fragments remain.

To raise the profile of the Trust and the efforts going on at Bletchley Park, there was a Royal Opening on 18th July, when His Royal Highness the Duke of Kent, who is Patron of the British Computer Society, officially declared the Bletchley Park Exhibitions open, and also declared the Launch of the Colossus Rebuild Project. The rest of this article is an insider's eye view of that day.

For someone who has read about and is fascinated by the wizardry at BP during the war but has never visited the place, driving up to the entrance with the stern warning notices that it is Government property, the security guard (civilian, not military!) and the sight of the long, low, bomb-proof buildings brings a lump of nostalgia to the throat.

Many of the buildings, empty since the end of the war, have their windows boarded over for protection from vandals. You pass the Mansion, looking exactly as it does in the photos in the books, with the lawns and trees and the lake below.

To actually walk up to the faded, decrepit wooden Hut 6, where the initial breaks into the improved Enigma cipher machine were made in 1939 and 1940, and to place one's hand on to the warm wall, almost brings a tear to the eye. (The winter of 1940 was particularly severe, and one of the huts was heated by a greenhouse heater!) Such uncomfortable conditions, and such magical, exciting, never-to-be-repeated work was done in there!

Across the way is Hut 11 where the first Bombes were housed, and over there beyond the green grass is the utilitarian-looking H-Block, where the first Colossi worked. In that building are most of the present-day exhibitions and the rooms where Colossus will be rebuilt.

The Royal Visit day was one of the many very sunny, hot, summer days that we have been blessed with this year. Security was tight: we had to have our passes applied for and received a week beforehand. I believe about 800 guests were invited, and I guess that 600 turned up. Very many of them were elderly, former workers at BP, and given dispensation by GCHQ to admit to the work they did.

Last admissions were at 1030 am, then the barriers were closed until about 1100 when His Royal Highness arrived and was welcomed by the Lord Lieutenant. Unfortunately, the crowds of guests were not allowed to go into any of the buildings until after the tour by HRH, so they had to wander round among the trees and look at the buildings from the outside for most of the morning. Somewhat tiring in the hot weather!

The welcoming ceremony was at the Mansion, the focus of the park, and the party was then driven to the exhibition tour in a series of beautifully restored WW2 jeeps, with pennants flying from antennas, driven by uniformed "Military Police". The Duke's party was then escorted round the exhibitions by Tony and Margaret Sale.

I will just mention some of the exhibitions which I had time to see.

The first room contained the collections of The Buckinghamshire Aircraft Recovery Group. Here are sad reminders of the Battle of Britain and after, with pieces of wreckage of Spitfires and Messerschmitts, Junkers and Heinkels, which have been dug out of the ground. The names of crews have been traced, and inscribed near what is left of their machines. There is a complete Rolls-Royce Merlin engine, the type which powered the Spitfire, with damage showing the awful force with which it hit the ground.

Further along in H-Block, the US Forces Re-Enactment Group has converted several rooms into part of a US Infantry base. One room is the GIs' bunkroom, beds made up and lockers tidy, pin-ups on the wall, and an old radio playing Glenn Miller. Another is an officer's room, with desk and maps of Europe. There is a quartermaster's store, and a couple of rooms of memorabilia pertaining to the US activities leading up to and including the D-Day invasion. Uniformed "GI"s were on hand to explain things — I noticed a senior present-day US officer engrossed in conversation with one of the guides.

Leaving the Infantry, the visitor next finds himself at the start of the Cryptology Trail. It is very interesting to move along the corridors from room to room viewing the various activities, which start with the enemy enciphering and transmitting a message. The intercept room has operational National type HRO receivers, where the operators write down the morse messages and then send the encoded intercepts through the telegraph exchange and motorcycle despatch riders to Station X, as BP was known.

We saw a mock-up of the registration room and the various stages of decoding and assessment prior to sending-on the intelligence to field commanders. Visitors can see a real Enigma machine, with one of the code wheels opened up to reveal the random cross-connections — a rare sight. There are also Lorenz and Siemens telegraph ciphering machines, for which Colossus was built to crack the wheel settings. The role of the pre-war Polish codebreakers is not forgotten, but more artefacts will be needed there, as perhaps also in the decoding stages after intercepts were registered. It is already an interesting exhibition, and is potentially stunning.

Following the Cryptology Trail, the visitor enters the Computer Exhibition, which has been staged by the Computer Conservation Society. It includes an almost-working Elliott 803, rescued from a barn and dating from the mid 1960s. There is an IBM 1130, a Burroughs Visible Record

Computer, some DEC equipment, and an early Sperry drum which is very heavy and is parked in the middle of the room.

Robin Shirley has put on a very good display of equipment showing the evolution of personal computers, from the Altair through North Stars and other S100 bus machines to later odd-balls like the Sinclair QL. Appropriate peripherals and software are also on display. The line ends with a modern 486 PC on loan from Olivetti: this is displaying my graphical simulator of the Ferranti Pegasus, thus nicely closing the loop back to the earliest vacuum tube machines.

I had also provided a working nickel acoustic delay line store dating from 1956, which stores and counts 42 bits, and requires voltages of +300v, +200v, +13v, −10v, −20v and −150v, as well as heaters and standard clock signals. Don't let the children get their fingers too close to that exhibit! For fun we also had a relay machine which I built in 1952 to play noughts and crosses.

The Duke of Kent spent five to 10 minutes in the Computer Exhibition, took a great interest and asked extremely relevant questions. It was a great pleasure for those of us manning the exhibition to see that we had influential support for what we were doing.

Next to the Computer Exhibition is the Electronics and Radar room. There is a very large collection of equipment here, most of it familiar from the World War, including BC221 wavemeters, a Bendix radio compass, and masses of British radio equipment and radar sets of various kinds. There is a Baird Televisor from about 1933, with its rotating perforated aluminium disc and neon lamp behind, giving 30 lines resolution on a picture about the size of a large postage stamp.

It is most interesting to make a comparative assessment of the manufacturing quality of the wartime military equipment made in various countries — German solid and precise, American efficiently made and neat, Canadian a cross between American and British, and British, well, thrown together in a hurry but working when things were desperate. It is rumoured that one of the people who staged that exhibition has access to 300 tons of wartime electronic equipment!

The Duke next moved to the Colossus Rebuild Room, where he met some of the designers including the team leader, Dr Tommy Flowers, now in his eighties but still very alert and knowledgable. Stacks of equipment have been accumulated and lie in piles on the floor. A PC running a CAD system is on one table: it is being used for re-creating drawings which would have been hand-drawn in 1943.

In the centre of the floor is a pile of steel channel sections and angle iron ready to be cut up, drilled, painted and assembled for the racks of the machine. There are some beechwood strips carrying link sockets, identical to those used in Colossus, and rescued from old Strowger rural telephone exchanges which are being replaced with digital electronic exchanges. The last of those exchanges will be scrapped in 1995, which shows how perilously near to too late is the rebuild project now.

The Royal Party then embarked on the jeeps, and other VIPs travelled in a 1940 bus, to see the Motor Pool, containing numerous wartime vehicles preserved and operated by another enthusiasts group. The Duke then arrived back at the Mansion, where he unveiled a stone tablet marking the occasion, before entering the building to see the Winston Churchill exhibition.

At last, the crowds of guests could go round the exhibitions themselves, and into the welcome coolness. Those of us on the stands were now busy for the rest of the day meeting old friends, explaining what was on show, and snatching a quick look at the other exhibitions as well.

What a day! It was a milestone on the long road to the Museums Campus, and very satisfying to all the volunteers who had come from many parts of the country to get everything presentable in a very short timescale. Particularly, the active members of the Trust are to be congratulated on their vision and hard work to get so far on almost no funds.

This article was published in modified form in the October 1994 issue of The Analytical Engine*, newsletter of the Computer History Association of California.*

Memories of the Zebra

Don Hunter

Zebra is an acronym for the Dutch words Zeer Eenvoudig Biner Reken-Automaat, which means Very Easy Binary Calculating Machine. It had a Dutch name because it was designed by WL van der Poel in the Dr Neher Laboratory of the Netherlands PTT. Standard Telephones and Cables Limited undertook the hardware design at Newport in South Wales. First deliveries were in 1958, and the company built at least 40 machines in all, of which two thirds were exported. The 600 valve machine had a power consumption of 7kw.

Zebra was similar to Pegasus but with half the number of valves. It was a serial machine with a 33-bit word and a bit rate of 128Kcs. Main storage was on an 8K word drum with 256 tracks running at 6000 rpm, and fast access storage consisted of 12 single-word registers made by pairs of heads on the drum, all with parity checking.

The arithmetic unit had the usual double length accumulator as two more registers, while input and output were via a pair of paper tape readers, a pair of paper tape punches and a teleprinter. An example of saving on hardware where possible was the programming of the teleprinter waveforms directly: this could now be a problem when writing a simulator.

The control console included a display, a telephone dial for small input, half a dozen test switches, an efficiency meter to measure non-waiting time, keys for causing a conditional stop, and keys for locking sections of store, all of which was available if needed. There was also a loudspeaker which clicked once for each instruction obeyed, making a musical note. At one installation used for minimising the cost of making cattle food, a practised ear could judge when convergence approached.

Ancient Greek mathematicians would have approved of the simple design, which mainly depended on two features: a fast switch for selecting tracks on the drum; and, more interestingly, the 15 function bits of an instruction.

The drum amplifier had to be able to read from any track the word following one which might have been written anywhere else. This was achieved by allowing an inter-word gap of seven bits. The switch itself was made using transistors. The selection was so fast that a diagnostic program could detect an open circuit head or folded addressing within two thirds of a second: even a dozen years later, the Burroughs B6700 could only do this 10 times faster on a set of fixed head discs.

Function bits had natural effects. For example, two of them specified how the main and register stores on the one hand were connected to the arithmetic and control units on the other hand, while two more determined the direction of transfer. Any instruction could be conditional on accumulator states (negative, clear, odd) or on the test switches, but a few of these opcodes were spare.

Although the bits acted almost independently (dreaded microcoding), one quickly learnt phrases for common operations such as subroutine calls, or setting up and testing loops. Indeed the Newsletter included useful snatches of code.

There was even a challenge, like Fermat's Last Theorem, which held that the operation of reading or writing five successive words on the drum was impossible. As an example of the power of this architecture, the bootstrap program was reduced from four to just two instructions without special hardware assistance.

As well as the 15 function bits, an instruction had a 13-bit store address and five bits for registers and I/O devices. A sequence of instructions using only the registers ran at full speed, but after a store-transfer instruction was executed the control usually fetched the next instruction from two locations further on. This was the best choice and helped to achieve optimum coding, though there was also scope to run at full speed entirely in the registers.

Multiplication and division were by subroutines working in exactly this way ("underwater programming") and were as fast as serial hardware would have been, thanks to a couple of conventions which applied to one of the registers. Utility programs could also be written to run only in the registers and the locked track zero, for example to dump or re-input parts of the store in checked binary code.

Normal Code was the name of the assembler, and many a programmer could recite the bit mnemonics, known as the Dutch alphabet (AKQLRIBCDEV421W), as quickly as ABC. The manual for it was actually a printed book with hard covers. Normal Code occupied the top 1K of store although, as previously mentioned, this space could be used after input.

Programs were built from subroutines on paper tape and were linked together without the user needing to know where they were stored. A trace utility, outside the 1K area, reported progress in assembly code terms under control of the test switches. Binary and source code tapes were about the same length.

But what about the waiting time for operands? Programmers sometimes had to make an effort to get a loop into a multiple of the 32 words of a drum revolution, but the efficiency meter was usually between 30% and 80%, and always at 50% for the floating point interpreter (which I shall come onto later). At one installation, management visits were anticipated by starting a program which displayed 80% efficiency!

Simple Code was the unheroic name of the programming system for casual users, in which most scientific and engineering programs were written. Amazingly, it was mostly the work of a blind and deaf programmer, van der Maes, and was described by Ord-Smith in an article in APIC volume 1. It occupied 2K of store just below Normal Code, and was recognisably derived from the Edsac I instruction set with the addition of index registers, labels, many built-in functions, a trace facility and nine digit floating point arithmetic. It is said that while van der Poel attended an Edsac programming course he was shown a cabinet containing some drawings of electron orbits made by an obsolescent analogue machine, and remarked, "Ah yes, an orbituary!".

There was also a Matrix Interpretive Scheme and an Algol compiler which translated programs to paper tape for loading and running by a separate interpreter. The Algol implementors chose a full version of the language which was capable of certifying Quicksort without the changes required by 803 Algol, and it was reported to have run Knuth's recursion test, Man or Boy, as PDP-10 Algol managed to do on its fourth release.

Nevertheless, the loading time of the translator and interpreter made it a clumsy alternative to the load-and-go Simple Code, and there were not enough users encouraging the developers to iron out minor errors and make it reliable.

Our machine at STL was used for scientific and engineering work such as calculations on fibre optics and telephone traffic simulations. Long unattended runs of up to 48 hours were commonplace. It was maintained by monthly visits of an engineer who distributed girlie magazines to prevent interruptions to his schedule.

He used to tap the plug-in units with a policeman's truncheon while the machine was running a test on marginal power settings with output to the teleprinter in case of trouble, although a stop was just as likely.

Sometimes faults were hard to locate. In particular, there was one on a foreign installation where the symptoms were just that the wrong results came out of some simultaneous linear equations from time to time. It turned out to be caused by a track selection fault which, as luck would have it, affected only the data and did not cause a parity failure.

Zebra's transistor-based successor was designed by a committee after the window of opportunity for such a machine had passed. It included 8K of ferrite core additional storage, magnetic tape units and a parallel multiplier. This had a diagnostic program capable of identifying single faults down to the component level, and it seemed as if two diodes were redundant. "It's easier to understand and, by the way, if you throw in an extra wire you can have a divider", the designer remarked, but he forgot to mention that the result appeared from the least significant end. This meant that it would emerge in two or three word times, as for multiplication, or about a week later in bad cases.

Another thoughtful proposal, aired at a users' meeting, was for switching off the machine after unattended night runs: it used one of the three remaining V opcode values. A voice was heard from the back asking, "Could we have one of the other two for switching it on?".

Don Hunter was in charge of the Zebra installed at STC's research laboratories (Standard Telecommunication Laboratories Ltd, or STL) in Harlow from 1960 to 1963. He had earlier worked on Edsac I.

Zebra simulator

Don Hunter is currently writing a simulator of Zebra, and would welcome the loan of material from *Resurrection* readers, in particular the LOT issue 6 and tape programs, either as paper tapes or as printed output. Any reader who can help should telephone Don on Royston (0763) 838472, or write to him at The Old Vicarage, Elmdon, Saffron Walden, Essex CB11 4LT.

Evolution of the Powers Samas PCC drum

John Bauldreay

Recent issues of *Resurrection* have carried details of drum memory designs and tribulations in early classic computers. I would like to add some comments on the drum system of the more mundane Powers Samas PCC (Program Controlled Computer).

I joined Vickers Armstrong in Crayford in 1954 after a graduate apprenticeship at BTH (British Thomson-Houston) Rugby. This had been interrupted by a year in a sanatorium, which drastically changed my career hopes. A position in light electrical engineering close to home was required, and Vickers was but a bus ride away.

My first PCC task was the design of head amplifiers, but I soon found there were no serious heads, no serious drum, no serious coating... very demoralising. I well recall seeing a fitter emptying a small cigarette tobacco tin of its ash and dog ends before mixing an approximate selection of hardener and resin with a filthy spoon handle. Mouldings sometimes came out looking and feeling more like fudge than glass.

Nevertheless after much hard graft, hair-tearing and argument I slowly brought everything into line, and became the unofficial leader of the memory team. Tony Elliott (later of Mullard) was the undoubted leader on the arithmetic unit, and so we christened the PCC the Belliac (along the lines of Edsac, Univac, SWAC etc). On one occasion Major Guttridge (later of STC) nearly had apoplexy shouting louder and louder in English trying to explain the humour to some French visitors. We had a small placard made with Belliac printed on it.

Early recording heads were fiddly assemblies of mumetal laminations, phosphor bronze shims and epoxy resin. They were incompatible with any production concepts, and I feared that the exothermic reaction of the epoxy and the mechanical lapping of the head face could well wreck the mumetal's magnetic hysteresis properties. So I went to the inferior but more stable and machineable ferroxcube. The 0.001" air gap was cut with a tiny paper wheel driven by an air turbine at 25,000 rpm. This technique came from the machine shop foreman who had previously used it to make moulds for plastic toys!

The heads were mounted individually, projecting through radial holes in the mild steel shroud. I was initially unable to get this changed to bronze, and so the head mountings had to be compensated against temperature differentials between the shroud and the bronze drum.

Later however I nearly died when I realised that the field engineers would throw the cabinet doors open in the event of a PCC fault. The shroud would then shrink rapidly, taking the heads down onto the drum. I countered this by designing a fast acting temperature compensating element on the outside of the mounting.

At the 1956 IEE Computer Conference I gained great satisfaction from several of the questions that arose. Did we share their head crashing problems? Was it true (as rumoured) that field engineers did not have to wait 30 minutes before opening the covers? Those were the days when people spoke the truth at conferences.

The temperature compensation was a crib from what I remembered from my School Certificate days regarding a constant effective length three element pendulum. My elements were aluminium, brass and a plastic.

Coating the drum was a matter of patient development, admirably aided by the same machine shop foreman. The early haphazard "method" not only gave inconsistent signal levels but also gave high oxide dust levels which bridged the head slits. The final epoxy resin mix gave adequate signals and a bone hard surface. It was machined down to a thickness of 0.0025".

Our head positioning method employed a tuneable cavity stethoscope. Experiments on an open ended drum showed that as the head was slowly screwed down onto the surface, it screamed through the earpiece when it touched. The head was then backed off by 0.001". This head setting idea came I think from the only mechanical engineering graduate to join us, a young South African named John Webb.

When I looked into the drum drive I found there was to be a $\frac{3}{4}$hp single phase induction motor, but this was clearly not suitable because of its unreliable capacitor start, its imprecise speed and its excessive torque.

At that time no clear ideas on the power arrangements for the machine existed, but with some quick sums Tony Elliott and I reached the conclusion that we were beyond single phase. This then allowed me to select an inherently self-starting three phase synchronous motor with its precise mains-derived speed.

What we did know was that the machine on condition would apply power to the valve heaters 30 seconds before the HT came on. So I looked for a motor which would take that long to bring the drum slowly up to speed. Having calculated the drum's moment of inertia I then further calculated that a $\frac{1}{16}$hp motor would be ideal. In the event it crawled up to synchronous speed in 25 seconds without a sign of a tremor. Mind you, I had by then managed to insist on the drum being dynamically balanced and using selected bearings.

I never did design the head amplifiers. Ben Gunn tells me that he designed the write amplifier, but I do not remember who did the read amplifier. I did design some well-screened pulse transformers to minimise write/read head crosstalk — this was the subject of another 1956 IEE conference question.

The senior management was ill defined, but notably involved the logic designer RPB (Yan) Yandell, JH (Luke) Lucas (later killed in a car crash), and the aforementioned Major Guttridge.

The only programmer I recall was Peter Ellis (later an ICL director), who was writing a program to minimise plate glass cutting losses for Pilkingtons. I saw him recently and he told me that the program had led to a 3% reduction in wastage, where each 1% meant £80,000 savings per annum.

I also remember Ted Cluff (later of the Institute of Data Processing Management) as a frequent visitor later on, though I cannot remember the subject matter. I suspect we were not quite sharing a wavelength. Bill Downing (also later an ICL director) visited us to discuss the training of field engineers, I think, and I well recall visiting him one Sunday with my fiancée and being impressed by his well behaved family.

Charlie Portman wrote in issue 10 that working on Sirius, Pegasus *et al* was fun. The PCC was possibly absorbing, but it was not fun, as it was so difficult to get ideas accepted. For example my temperature expansion and relative movement calculations were presented, but not believed. I had to spend three weeks getting a model built and tested in an oven before management would accept that the heads would indeed jam, and only then did they support me.

Also, the working environment at Vickers was near Dickensian, while the canteen was disgraceful, so we ate in an upmarket "greasy spoon" in Crayford — they even served chips with their Christmas dinner!

Nevertheless I did make some firm friends, notably Peter Williams (later of ICL Kidsgrove) and William (Ben) Gunn, who arrived late on the PCC scene. In both cases our families are closely entwined for frequent visits, weddings and so on.

British Computer Industry — Success Or Failure?

Nicholas Enticknap

> Why was the early promise of the UK computer industry not fulfilled? The Society held a debate on this question at the Science Museum on 24 February 1994, and it proved to be one of the best-attended Society events.

George Davis, who conceived the idea of the debate and organised it jointly with Chris Hipwell, set the scene with a summary of the events of the fifties and sixties. Davis argued that "Britain had an enormous start in computers", producing many of the pioneering models, but had subsequently fallen well down the world league table.

This was mainly, he felt, because there was too much computing activity in the UK for the size of the market the industry was addressing, and too little Government support in terms of firm orders. Davis pointed out that by the late 1950s there were eight British computer manufacturers (AEI, Elliott Brothers, EMI, English Electric, Ferranti, ICT, Leo Computers and STC) producing 29 models between them, plus seven industrial machines. "The general picture is of a greater diversity than the UK could support."

In the much larger US market, in contrast, there were only nine computer manufacturers at this time, each of which could because of its size support much greater R&D programmes, even though these programmes formed a smaller proportion of total turnover. "Comparing IBM with ICT, IBM had 20 times the turnover but 12 times the R&D. ICT was spending a far higher proportion of its turnover than IBM, and needed to as it had a far bigger range to exploit."

In addition, "research and development by von Neumann, Eckert and Mauchly and others in the late forties and early fifties was funded by US Government agencies, with guaranteed orders at the end. But in the UK, the computer industry was not seen as significant."

The upshot was that the US computer manufacturers controlled the industry by the mid sixties. Davis pointed out that by 1967 IBM had installed a total of 21,500 computers, while the UK's most successful manufacturer, ICT, had sold just 844. These included 400 of the still relatively new 1900 range, launched in 1964. That number is gigantic compared to the installed base of 30 or so for the Ferranti Pegasus, or just three for the Emidec 2400, but pales into insignificance compared to the 5730 IBM

System 360s installed — this range was also launched in 1964.

Support for Davis' view that lack of Government support was a key factor came from a contemporary computer user, Cecil Marks. Marks recalled how he was seconded from one of the Ministry of Supply's ordnance factories in 1955 to the National Physical Laboratory, where he became part of a mixed discipline team charged with finding out how computers could help administration in Government offices.

"Folk like myself tried to explain what office work was all about, and the scientists explained what the machines were and what they could do. By and large up to that time they had only been used for mathematical and scientific purposes.

"At the end of my period there we produced a report showing we could use them in the factory. There was a big meeting with a very senior civil servant in the chair. He went round the big table asking everyone's opinion, and they all said it was worth going ahead. At the end of the meeting, he acknowledged what we had all said, but said he thought we must wait: now was not the time to get into computers. This led to the ordnance factories losing ground for certainly 10, possibly more, years."

Hugh Ross produced a different explanation for the UK computer industry's failure: inadequate financial management, a subject he believes "is very little covered in the literature". He supported his case with several examples from his own experience.

His first example concerned the Ferranti Pegasus, and Ross' point here was that financial mismanagement caused a delay to the sales effort which seriously compromised Ferranti and handed a huge advantage to the competition.

After careful calculations, a selling price of £25,000 was arrived at. This was agreed with the National Research Development Corporation, which was to buy 10 of the machines, while Ferranti retained responsibility for selling them.

This was fine until the company decided that the costing of the machines was "grossly out: they were costing far more than £25,000 to produce". So the purchase price was raised. The NRDC took exception, and "a ban was put on the sales of Pegasus for nine months while the squabble was sorted out, just as the first sales were taking effect."

Another example concerned the Ferranti Atlas, widely regarded as one of the best and most influential computers of its day. "The Atlas computer was brilliant in concept, wonderfully engineered... But every academic had to publish his research, so CDC heard about the tricks without having to do the research. By the time we got Atlas marketable, CDC came along with the 6600 and pipped us to the post."

These were cases of incompetent commercial thinking. Another example shows that financial considerations sometimes didn't enter into the equation at all.

"I was number two to Bernard Swann. He charged me with setting up a computer centre: to go round, find premises, prepare them, accept machines and staff, and get the centre operational.

"I never had to produce a business plan, or a budget; I never had to account for expenditure, I never had to show that expenditure was within any agreed limit. There was no financial management at all."

By no means every speaker agreed that the UK computer industry had failed. Opposing the motion, so to speak, was Peter Hall who came to the rostrum after George Davis. He took the devil's advocate position that the UK computer industry was not a failure at all, and a very persuasive case he made.

Hall started by asserting that his former employer, ICL, "is a very successful company by anybody's standards", with a turnover of around £2.5 billion. "If the rest of the electronics industry had been as successful as ICL we in this country would be in a very different position. If we had done as well in communications equipment, in hi-fi equipment, in television, radio, video recording, cameras... if we had done as well as the computer industry the country would be a damn sight better off. So let's not go around bemoaning the fact that we have failed".

Hall then compared ICL with computer companies in other countries. "In Europe, what are the companies that survive? In France there is Bull: they rceive enormous Government support still, and it isn't a worldwide operator as ICL is. The same goes for Siemens, or Siemens-Nixdorf, in Germany — they are not in the same league in information processing that ICL is in."

And in the US? "We used to call them IBM and the seven dwarfs. What has happened to them? CDC has practically disappeared. RCA — the whole company has disappeared. GE gave up, NCR went into AT&T. Burroughs and Univac merged into Unisys, which is the only real competitor to IBM in the States of those seven dwarfs. But ICL has survived."

Hall paid particular credit for the UK computer industry's achievement to two people who, he said, did not usually get sufficient credit: Sir Ben

Lockspeiser and Lord Halsbury. They, said Hall, "were the sort of people who fiddled around with the rules at the Board of Trade and the Ministry of Supply to give out contracts, who were in modern parlance 'economical with the actuality of the legislation'."

Hall's opinion was supported from the user's point of view by Harold Gearing, who was an executive at the Metal Box Company in the early sixties when that company acquired a Ferranti Orion to replace its punched card equipment.

Gearing's overall opinion was that "Metal Box's experience from 1962 to 1975 compares very favourably to that of our American and European associates at that time who were using other equipment". In particular, he made the point that the Orion was well in advance of comparable IBM equipment of the time.

"In April 1966 I went to America to see what our associated company was doing on applications of computers to factory control. Directly I got to New York I was collared by their local IBM representative and taken up to Poughkeepsie to be shown the work they were doing on time- shared computers, and I listened for a few minutes to a lecture on the advantages of time-sharing.

"After a bit I got a word in that we had had time-sharing since September 1964. IBM was not able to show me any timesharing on its 360s."

About the speakers:

George Davis has been involved with computers since he joined the National Physical Laboratory in 1950. He is a committee member of the Society.

Cecil Marks got his first experience of computing when he was seconded from the Royal Ordnance factory in Nottingham to take part in an 18 month study of the potential of computers for use in Government offices. He is a former President of the British Computer Society.

Hugh Ross set up Ferranti's London computer bureau in the mid-fifties under the direction of Bernard Swann.

Peter Hall entered the computer industry in 1958 as manager of Ferranti's computer department, and subsequently held various directorships with first ICT and then ICL until his retirement in 1980. He is one of five former Presidents of the British Computer Society on the CCS committee.

Harold Gearing worked with the Metal Box Company as a user of Powers Samas punched card equipment, and from this perspective watched the development of the British computer industry with close attention from 1949. He is now the Society's archivist.

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

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

Letters to the Editor

Dear Mr Enticknap,

In our letters in issue 10, Harry Johnson and I made conflicting statements about Pegasus number 1. I am happy to acknowledge that Harry was correct in stating that this machine did go to Vickers Armstrong Aircraft at Weybridge. Because it had been upgraded with the larger drum and three "commercial" instructions, it was described by Vickers' staff as a Pegasus II, and I wrongly deduced that it could not be machine number 1.

I also agree with Harry that Pegasus number 1 was different from number 6. The drum size was the most conspicuous difference, and the machine in Manchester can hardly be Pegasus number 1 if it does not contain the numerous internal modifications necessary to accommodate the larger 7168 word drum.

The maintenance engineer at Vickers was involved in installing a Pegasus at Brooklands Technical College, and he confirms that this was number 6, originally delivered to Vickers in 1957. It is possible that Brooklands could have taken another machine later, but the drum and other modifications should be sufficient to determine which machine is now in Manchester.

It may be worth noting that Pegasus number 6 would be more truly representative of a Pegasus type I than the much modified Pegasus number 1, although that one had more history.

Yours sincerely,

Derek Milledge
Bracknell
Berkshire
24 October 1994

Editorial fax number

Readers wishing to contact the Editor may now do so by fax, on 081-715 0484.

Working Party Reports

Elliott 401

Chris Burton, Chairman

We have at last had a mini Working Party meeting at Blythe House. The machine is still on pallets in the erstwhile Elliott Room, with just enough room to get round the cabinets. Some further progress was made in deducing the logic diagrams, though due to the lapse of time since we last did any useful work there was much trying to recollect where we were up to! Only a couple of Working Party members took part as there is little else that can be done on the system at this stage.

The plans for improving the larger computer room are progressing in the sense that we have submitted proposed requirements for false floor and services, and at least part of what we would like has had budget approved. However, the actual progress with installation is not fast and it will be some months before the Elliott 401 can be moved into its new location.

We have gratefully received a short annotated Elliott 401 program from Neil Gilbert of Cambridge — this is a welcome and invaluable addition to our small collection of programs and routines. We look forward to when we can actually try these on the real machine.

North West Group Pegasus

Charlie Portman, Chairman

We have nearly completed the cleaning of the packages by dry brushing. The drum will be disassembled and cleaning started when a suitable space is made available. We expect to finish this job by the summer. The working party manned a stand for the two days of the "Friends of the Museum" weekend in late October, and gave a demonstration of the nickel delay lines and the Pegasus simulator.

Science Museum Pegasus

Chris Burton, acting Chairman

There have been no Working Party meetings during the summer because the Old Canteen has been gutted and rebuilt around Pegasus. While the builders were at work the machine was protected by a polythene enclosure, but much of the ancillary equipment has been less well covered — it remains to be seen how much will be in good order when we next meet.

Pegasus has had an attractive room build round it, with a good viewing area and enough space to get an oscilloscope trolley round. The room is lockable and secure. The spares and stores room has been demolished, and all the little-used spare parts have been sent to Wroughton temporarily, later to return to Blythe House. We have retained some storage cupboards in the computer room to hold the more vital spares and documents.

A Working Party meeting will be held in the next few weeks to identify and stow the spares, recommission the ancillary equipment, and bring Pegasus back to a demonstratable standard.

Elliott 803

John Sinclair, Chairman

The resumption of work on the Science Museum's Elliott 803 still awaits the completion of the false floor in Blythe House. In the meantime, we have been making good progress on the restoration of our other 803 at Bletchley Park. The machine is now close to being operational again.

We have been fortunate to receive as a gift from the RAF a new battery. This is worth around £2500, a sum of money the Society would have been unable to afford, so we are very grateful. The new battery has made a big difference: the machine now hums into life at the touch of a button even when cold.

We have been working hard on the paper tape system, repairing or replacing the minilog elements, many of which have failed during the machine's long period of inactivity. Once the reader is operational, we shall be able to carry out much more extensive testing of the processor and memory. At present we are limited to such tests as we can perform using the keyboard. With a working paper tape reader we can enter proper diagnostic test programs, which will give us a much better idea of the state of the machine.

S-100 bus

Robin Shirley, Chairman

The main activity since the last issue has been the mounting of a 50 foot display in the Society's section of the Bletchley Park museums complex, showing the development of microcomputers and microcomputer components.

The display starts with an original Altair with teletype, and includes, in chronological order, a North Star Horizon with floppy discs and VDU, a Sinclair QL with microdrives, and an early Amstrad PC, and ends appropriately next to a modern 486 running the Pegasus simulator in an adjoining exhibit. It was ready in time for the official opening of the Bletchley Park Trust exhibitions on 18 July by HRH the Duke of Kent, who was shown the exhibits and had a quick go at Psion Chess on the QL.

North West Group

The North West Group would particularly welcome any material — data, manuals, film — on the Ferranti Sirius and Metrovick 950 computers. Anyone who can help here or who would like to play any part in the group's activities should contact secretary William Gunn at 23 Chatsworth Road, High Lane, Stockport, Cheshire SK6 8DA: tel 0663 764997.

Forthcoming Events

14-15 January 1995, and fortnightly thereafter until the end of April Guided tours and exhibition at Bletchley Park, price £2.00

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

7 February 1995 North West Group meeting

J Walker will speak on “The digital computer Deuce - some reminiscences”.

25 April 1995 North West Group meeting

TR Duffy will speak on “Computer maintenance in the fifties”.

17 October 1995 North West Group meeting

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

5 December 1995 North West Group meeting

L Griffiths will speak on “Computing at Rolls Royce”.

The North West Group meetings will be held in the Conference Room at the Museum of Science and Industry, Manchester, at 1730. Refreshments are available from 1700.

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