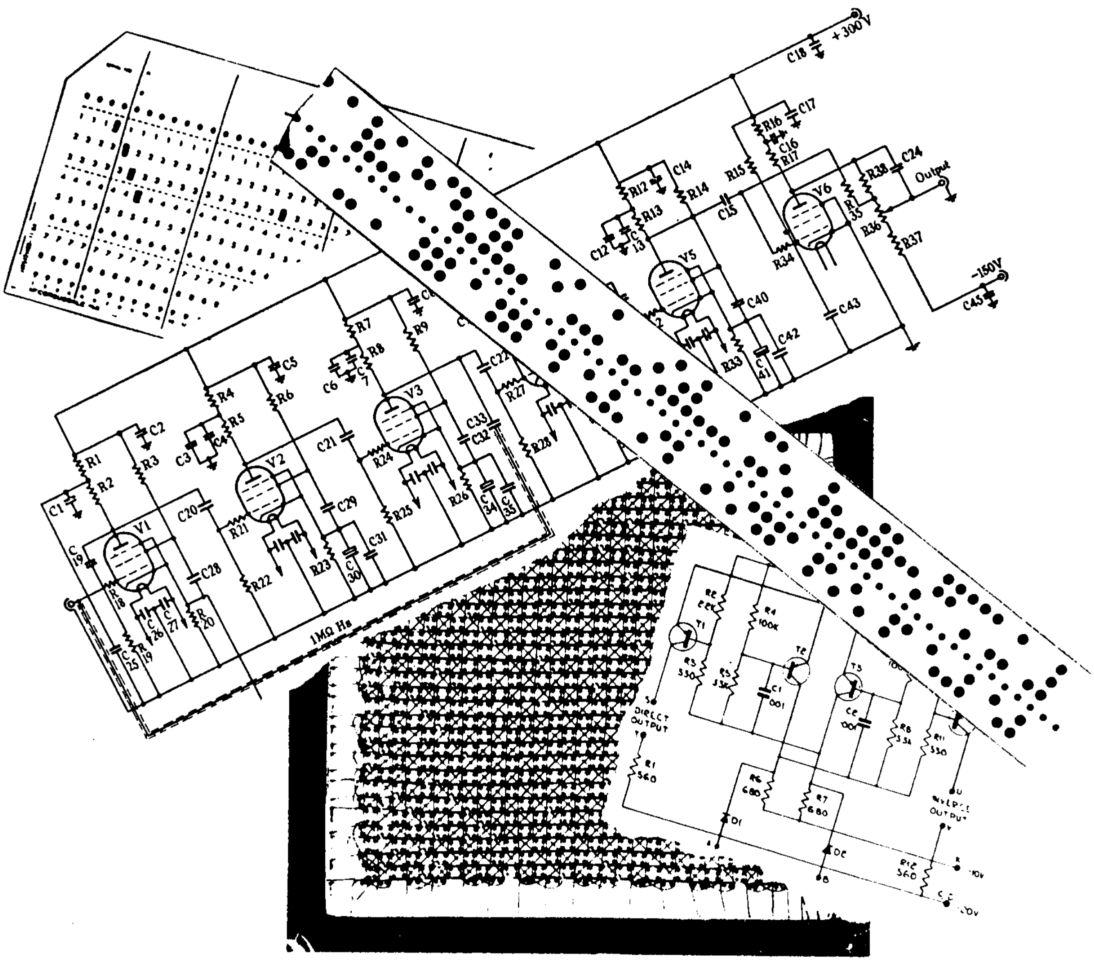
Issue Number 16 Christmas 1996

Computer

RESURRECTION

The Bulletin of the Computer Conservation Society



The British Computer Society

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The National Museum of Science & Industry

Science Museum

Computer Conservation Society

Aims and objectives

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

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

The aims of the CCS are to

- Promote the conservation of historic computers 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 Bull HN Information Systems, Digital Equipment, ICL, Unisys and Vaughan Systems.

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Editorial

Nicholas Enticknap, Editor

It has been an eventful few months for the Society, with the arrival of a new Chairman and Secretary, developments in the Science Museum's plans for computing displays and work proceeding on a variety of reconstruction projects, including Colossus and the Manchester Small-Scale Experimental Machine. We report on all of these developments in the following pages.

In addition, a hot news item that came to hand just as we went to press is that the Society now has its own Web page. This has prompted us to start a new feature containing addresses of various electronic information sources: see page 27.

There have also been full meetings programmes in both London and Manchester. One well-attended London event was the ICT/ICL 1900 seminar in May, and the talk from this event covering the background that lay behind the development of this range appears in this issue: it is based on the joint presentation by Hugh Devonald and Derek Eldridge.

Our other two main features concern computers that are rather less well known than ICL's successful first mainframe range. We are very pleased to be able to publish an account of the development of the STC-manufactured Zebra computer straight from the horse's mouth, so to speak: it is an edited version of the presentation given by the machine's designer, Professor van der Poel, to the Society in London in autumn 1995.

We are also pleased to publish an account of the very first computer ever built by EMI, a one-off valve machine that has hitherto received very little publicity anywhere. Ron Clayden has kindly supplied this article. The Committee would like very much to run on a seminar on the later Emidec machines, but we have so far been unable to make contact with any of the principal figures involved. If anyone can help us in this endeavour, we would be grateful if they would get in touch with George Davis.

We anticipate this issue should reach members at around the same time as their Christmas cards, Post Office permitting, so we take this opportunity to wish all readers a Happy Christmas and an enjoyable 1997.

News Round-Up

It is with great sadness that we report the death of Gordon Scarrott in October. Gordon was a computer scientist of great distinction, a man who, in the words of Chris Burton, was "one of the most interesting innovators of the fifties and sixties, and a vigorous proponent of novel architectural ideas in the seventies and eighties".

Gordon was a keen supporter of the Society, and gave a most interesting talk to members about his experiences in Ferranti, ICT and ICL research projects, and about his original views on information engineering, in London in March 1995. This was repeated for northern members in Manchester in April 1996, with Charlie Portman reading the script as Gordon was unable to give the talk himself on this occasion. This talk formed the basis of two articles in *Resurrection*, in issues 12 and 13.

We hope to publish a fuller appreciation of Gordon Scarrott in a future issue.

- 101010101 -

There have been several key changes to your Committee recently. The first of them, which actually took place just before we went to press with *Resurrection* issue 15, was the resignation of our chairman Graham Morris after four years at the helm to concentrate on his many other activities, which include a role in the planning of the 40th anniversary celeberations of the British Computer Society in 1997-98. Happily he remains a Committee member, so we shall continue to gain the benefits of his wise counsel.

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Graham has been succeeded as Chairman by another distinguished former BCS President, Brian Oakley. Brian is best known as the chairman of the committee that was responsible for implementing the Government programme of fifth generation computing research that followed the Alvey Report in the 1980s. He has always been an enthusiastic supporter of our Society, and contributed a Guest Editorial to issue 9 recalling his early experiences of computers at TRE in the 1950s.

Tony Sale has resigned as Secretary, a post he had held since the formation of the Society, to concentrate on his many activities at Bletchley Park. In recognition of his key role in the creation of the Society and his tireless endeavours on its behalf over the past seven years, he has been appointed to the new position of Vice-Chairman of the Society.

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Tony's work at Bletchley Park was itself honoured in October with the rare award of an Honorary Fellowship of the British Computer Society.

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We are fortunate indeed to have enticed Hamish Carmichael to take over Tony's Secretarial duties. Hamish spent his entire career at ICL, joining Powers Samas in 1958 and subsequently working for first ICT and then ICL before retiring in 1994. He has put this long service to good use by compiling a book that recounts some of the more amusing and bizarre moments in ICL history, which is reviewed on page 23. Hamish is probably best known outside ICL for his marketing of the unique CAFS search engine in the late seventies and early eighties.

- 101010101 -

Meanwhile, it is with regret that we record the decision of Chris Hipwell to resign from the Committee. Chris joined the Committee in 1990 after playing an instrumental role, in his position as Editorial Director of *Computer Weekly*, in securing sponsorship from that publication for our Open Days in 1990 and 1991. More recently he has acted as Chairman of the Meetings Sub-Committee responsible for organising Society events in London. We wish him a happy retirement.

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His departure means that some assistance will be needed with the organisation of London meetings. Any Society member who would like to join the Committee to help should contact either George Davis or our new Secretary, Hamish Carmichael (contact details are on the inside back cover).

A 25 minute video of the inauguration ceremony for Tony Sale's replica Colossus on 6 June 1996, when HRH the Duke of Kent formally switched on the machine, is available from the Bletchley Park Trust at £ 7.50.

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Tony is now involved in another, related, reconstruction project, this time of a Turing Bombe. As a first step he constructed a simulator to find out how it works and points out that it, running on a 100MHz Pentium processor, takes 18 hours to do work which the Turing Bombe completed in 15 minutes! Sponsorship has been secured from Quantel, but more is still needed.

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The number of visitors to Bletchley Park is steadily increasing. It currently averages 400 on a normal weekend day, while the total over the August Bank Holiday weekend topped 1200.

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Chris Burton is still looking for components for his Small-Scale Experimental Machine project, and especially half-watt resistors of 1940s or 1950s vintage (not, of course, transistors, as we erroneously and anachronistically printed in the last issue).

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Simulators

A simulator for the Manchester University Small-Scale Experimental Machine (SSEM) has been added to the collection at our FTP site. Others are available for Edsac, Pegasus and Zebra. Access details can be found on page 27.

Anniversaries in 1997

Two major anniversaries fall in 1997. The invention of the transistor 50 years earlier was to make the computer industry, as such, possible: without it the prediction that six computers (or three - there are several versions of this anecdote) would be enough to serve the needs of the entire country might well have proved correct.

Second, the British Computer Society will be 40 years old. The Society started life in 1957 with a membership of 449, which seems in hindsight an astonishingly large figure. The inaugural president was Maurice Wilkes.

Other 1997 anniversaries which may be of interest to readers of *Resurrection* include:

380th John Napier invented Napier's Bones in 1617 - an early arithmetic aid which was in use till quite recently (see facing page). Napier died the same year.

175th Charles Babbage formally presented his first Difference Engine to the Royal Astronomical Society in 1822.

140th Charles Babbage started work on the Difference Engine number 2 in 1847: this was the device reconstructed by the Science Museum and put on display there in 1991.

110th Herman Hollerith started trials of a punched card-based tabulator in 1887, filing patents in the same year.

90th The British Tabulating Machine Company (British Tab) started trading under that name in 1907.

40th formation of two major industry companies, Control Data (CDC) and Digital Equipment (better known to everyone except itself as DEC) in 1957.

40th the death of John von Neumann, who gave his name to the basic architecture used in virtually all computers, in 1957.

30th The National Computer Centre established its Basic Certificate in Systems Analysis in 1967.

25th Diablo introduced the world's first daisywheel printer in 1972.

20th Digital Equipment (or DEC) launched its best-selling 32-bit VAX minicomputer range in 1977.

20th the death of Sir Frederic Williams, one of the leading early British computer pioneers, in 1977.

Evolution of the Zebra

Willem van der Poel

The designer of the Zebra computer discusses his earlier experiences of computer design, describes the major features of the machine and outlines some of the problems involved in programming it.

The Zebra computer does have something to do with the striped beast. Instructions in Zebra were written on every second line to give the opportunity to fetch the instruction and then fetch the operand in the intermediate time. So we regarded it as a striped beast where the instructions were written on the white stripes and the data on the black stripes.

Joking aside, Zebra is an acronym which, when translated, means `very simple binary computer'. Sometimes I'm called the father of the Zebra: my wife is called the mother of the Zebra because she coined the acronym.

My interest in computing started at an early age. Even in elementary school I was very bad at doing sums, so I had desk calculators and discovered how Napier's bones worked, and I did my little sums with these artificial means.

That was before the war. In 1944, when there was no light or electricity, I went one step further and designed a computer. I wanted to build it using relay technology, and I still have one of the drawings from this design.

An interesting feature of it is that it was designed to perform a three-level subroutine, using three counters or registers. It was not a stored program machine, but a fixed program device only able to do things it was designed for. It was impractical and I didn't have the technical knowledge to build it, nor the money, so it was never built.

The opportunity to build a computer came when I went as a student-assistant to Professor NG de Bruijn at the University of Delft. This was originally called *Arco*, but was later re-named *Testudo*. That word means tortoise in Latin, and was chosen because the machine was so terribly slow. It could do in 16 hours what we human beings could do in eight, if we worked intensively for the whole day.

There is never the opportunity to do this, of course, while the Testudo could be loaded with input data by paper tape and left alone for the whole night. So it was useful. We had it working by 1952. It took five years to complete, by different people - I only made the design and built the first boxes, while successors finished it.

Testudo was only used for optical ray tracing. It was a stored program machine in the true sense, but there were very few live registers and the lens constants were plugged into a plug board. For output we used an IBM typewriter: at that time there were no such machines with actuating magnets under the keys, so we had to fit coils ourselves. That was a pioneering time, and I remember having to wind several relays in a special way myself on the lathe.

The next machine I designed was going to be the first electronic machine in the Netherlands. It was called *Ptera* (PTT Electronic Reckoning Automat) and was built at the PTT research laboratory, named the Dr Neher lab after a former Director General, under the direction of my boss at that time, the late Professor Kosten.

The machine had three bays of registers, known as the A, B and C accumulators. C was the control register, and A and B were a double length accumulator.

During the construction of Ptera a working drum was available, and one bay of the 30-bit accumulator. Out of these parts we built a temporary experimental machine with a minimal control box by splitting the 30 available bits to form three registers of 10 bits and coupling this to the drum.

This machine was later called *Zero*. It had the functional bit coding of the later Zebra and hence was its precursor. As we needed the parts to continue with the construction of Ptera, Zero existed and was run for only 14 days[1].

Ptera had a drum with fixed heads. This drum was nickel plated. An experimental drum was once made by an external plating firm. When we got it back, it produced absolutely no output signal. It turned out they had chromium plated it: "it looked so much brighter", they said!

This same drum had a single head. We wiped it clean with a magnet, which used to produce a pulse on the oscilloscope. Suddenly one evening we saw the reason: we had not yet switched on the light, so we could see a little spark jumping from the head to the surface of the drum. The drum was belt driven: this acted as a sort of van der Graaf generator and charged up the disc.

[1]A full description of the logic of Zero can be found in "A Simple Electronic Digital Computer" by WL van der Poel, Appl Sci Res, Section B, Vol 2 (1952).

The remedy was very simple - a little contact spring connected to earth. The amplifiers hung by elastic bands because they were so microphonic. The very low signal had to be amplified to 100 volts using valves, an amplification factor of 100,000.

The head had a screw to regulate the distance from the drum. If the head touched the drum and detached the nickel, it cost £ 3500 in early 1950s money to get it re-plated. This never happened to us.

Zebra had about the same structure as its predecessor Zero but now had 15 functional bits instead of only four. With this technique, every bit controls its own gate, and every combination of bits is possible. The Zero had only four bits it could use: 1) use the next word as data or instruction; 2) store it or fetch it; 3) clear the accumulator (or do not); and 4) do it "+" or "-". Zebra had 15 independent bits of operation, so the things you could do with that were really marvellous.

Ptera ran from 1953 to 1958 and the up-time was about 50%. The other 50% was repair, tube testing and so on. When Zebra came in we hoped to have the two machines in the same room, but we found the room was too cramped so we scrapped the old machine.

We did this with pleasure, as it had troubled us for five years with problems and repairs. Not a bit has remained. We had no historical feeling at that time. We should have said "give it to a museum" but no; we actually snipped the cables with pliers and it was gone before the next machine came in.

There were several universities and other labs interested in our Zebra design, and we tried to find out whether Philips was interested in manufacturing it. But they said "No, we have so much obligation to IBM, delivering parts and subassemblies, that we don't want to meddle in computers." They missed a big chance. We eventually found Standard Telephone & Cables prepared to do the manufacturing.

Later on Philips missed another chance when the Mathematical Centre, which also built pioneering machines (they designed the X1, one of the first fully transistorised computers), also looked for a company to make its machines - Philips wouldn't take that on either.

There were about 10 Zebras installed in the Netherlands in all, at the PTT laboratory, at the Universities of Delft, Groningen and Utrecht, and at the Aeronautical Research Lab among other places.

Inside Zebra there was a closed drum with 256 heads, and also short delay lines with a capacity of $^{1}/_{32}$ of the drum with two heads, one for reading and one for writing. They acted as recirculating registers. I give credit to the Ace computer; we were inspired very much by the delay lines - long and short - of that design. The long delay lines could be regarded as the normal tracks on the drum, containing 32 words, and you had a waiting time. The short lines (only the accumulator and 15 registers, no more) were used for fast operations.

However, the whole design of Zebra was such that the instructions were normally placed on the white lines of the Zebra with the operand on the black lines in between: in that way there was no loss in time. Actually we got a typical hit ratio of 30%-40%; we could run a demonstration program using 100%, but it only tested parity.

The perfect engineering of Standard Telephones & Cables must be credited with the head switching mechanism. It contained transistor switches, very advanced for their time and fast enough to switch between heads in the inter-word gap, which was only seven bits long. That was very remarkable. There were other innovations, too: the back plane wiring was printed circuitry - also very revolutionary.

The drum rotated at 6000 rpm, while 128 microseconds was the basic clock rate of the machine. The drum revolution time of 10 milliseconds was also used for timing the teleprinter which required 20 milliseconds for every pulse: there was practically no additional circuitry needed. The magnetic head of the drum had a sleeve with two screws, one left-hand and one right-hand, with slightly different threads. So as you turned the sleeve the head moved a very small distance.

Zebra's A and B accumulators could be coupled for shifting so they could act as one. There were also fake registers for constant "0" and for "1". There was even a fake register 23 which delivered the highest bit. The C control register was the only register that was not rotating on the drum - it was a series of flip-flops.

An important feature was the cross-connection capability. The A bit in the instruction controlled whether the drum was used for control (when 0) or for the arithmetic unit (when 1). The K bit specified which of these conditions applied to the registers. All four combinations of A and K bits were possible: for example if K = 1 and A = 0 then you had a kind of index register, or modifier, so you could modify a fixed instruction from the drum by variable contents of one of the registers. You could also for example take the next instruction and store the control in the fast store; that was for calling subroutines.

Don Hunter phoned me in December 1994 and told me that he had made an reincarnation of the Zebra in the form of a PC program[2] . We had done that before in an emulator, but we never included all the software in it. Most essentially he included the Assembler in bit-wise form. Once he had all that (the "LOT") he dug up the first old "LOT" issue 4, and brought it to work again. Then once you have an old issue you can feed in your versions and all the other programs. Fortunately I have kept a stack of all the old programs, and even all the old paper tapes, but unfortunately there is no machine in the university which can read paper tape.

Eventually we found a private museum in the Netherlands with a PDP-11/10 with a tape reader which could read it and convert it to a floppy disk (8 inch). From this we could do a second conversion on a PDP-11/44 to mag tape, and then on a third machine we could convert the mag tape to regular floppies of today, and thence to the hard disc.

So nowadays the full double length is working again, and Lisp is also working again, which I can demonstrate. Algol 60 has not yet been fully converted. We had a double length "LOT" for calculation in 16 decimals: we used two words, one for the head of the mantissa, the other for the tail plus the exponent. That works partially though there must still be an error in it. But as far as the simulator is concerned the machine is perfect. I must say that since Don Hunter made it, it has never been found in error in the central machinery. There have been frills and bells and whistles built in but that was on the outside: inside there has never been an error - quite remarkable.

A little about programming. Zebra had no multiplier or divider. It could only add and shift single step by single step. Multiplication was done by repeatedly doing combined shift and conditional add. The machine could do repeated instructions using the drum address as a counter when the drum is switched off: ie W bit = 1. The process continues until the drum address overflows. Multiplication was only three instructions long.

Division was more difficult: you had to subtract to see if it went, and if it didn't you had to add it again. But it was only two instructions. We used to call this "underwater programming" - setting up a number of instructions in short registers and then executing them. Sometimes you could set up filling say 10 short registers by 'prepare' instructions, and then executing them: they were modifying and tumbling over themselves and sometimes more than 100 instructions were executed for only six instructions set up actually. This underwater programming was very difficult to trace and we actually built an interpretive tracer to do it.

[2]This simulator, ZEBRA.ZIP, is available from the Society's FTP site (see page 3 for access details).

The champion of "trickology" was the square root. In most machines it is done by an iterative process. JG van Leyden, one of our trickologists, devised a method to do the square root by bit-by-bit microprogramming. The possibilities of the instruction code were not quite fit for microcoding the long hand square root, where you have to divide by the partial quotient plus some added bits. But van Leyden managed to do it with a very complicated correction scheme with strange constants.

The square root does 24 steps with the complicated process in six word times per bit and the remaining eight places by normal division steps of two word times per bit, resulting in a total of 121 word times, running at the full hit ratio of 100% efficiency.

I should give credit to another programmer who worked with me for 27 years, and has to be credited with most of the programming work behind Zebra. van der Mey joined me in 1951: he was a maths graduate but the year before he took his doctor's degree he got meningitis. He had been blind from the age of four; at this time he was 30 years old, and he became deaf from the same cause.

He wrote practically all the major programs - the simple code floating point, the double length floating point, Lisp, IPL 5, Algol, and others. Later on he worked on other machines for which he wrote Lisp, the PDP-8, PDP-9, great pieces of Algol implementation, and he worked on theoretical aspects of lambda calculus and combinators in later years. He is now 82 and still very strong and a very amiable man. We talked to him through a teleprinter line with a Braille box termination.

Editor's note: this is an edited version of the talk given by the author to the Society at the Science Museum on 11 October 1995.

How the ICT 1900 series Evolved

Hugh Devonald and Derek Eldridge

This article sketches the background and events that led Ferranti to adopt the FP1600 system for its new computer system - the system that became eventually the ICT 1900 range.

Hugh Devonald sets the scene... In the early 1960s, Ferranti had a number of computer designs that had been developed independently by different departments and, indeed, by separate groups within departments. Some were specialised, for machine tool control, airline seat reservations, and various military applications. There were also many general purpose machines, including Pegasus, Mercury (from 1957), Atlas and Sirius (1961) and Orion and the FP1600 (1963).

Some of us at that time saw the Ferranti family as running a charitable institution set up to gratify the desires of budding computer designers!

In 1963 Ferranti had a need, for both the UK and export markets, for a system in the medium price range, below the performance levels of Orion and Atlas. This system would be a successor to the reasonably successful Pegasus, Mercury and Sirius systems.

Some preliminary specification work had been done in the UK by Harry Johnson (in the sales department) and by researchers including John Iliffe on the Basic Language Machine. However, what was lacking was the sense of urgency needed to develop a system quickly.

This is where the Canadian subsidiary, Ferranti Packard, comes into the picture. Fred Longstaff and other engineers from this company had paid a lengthy visit to the UK in 1962 to study Ferranti UK ideas, including features of Orion. On their return to Canada, with help from some recruits from the UK, they designed and produced the FP6000 computer in very quick time, using engineering techniques proven in their seat reservation systems.

The first FP6000 was installed and running at the US Federal Reserve Bank in New York in March 1963. Ferranti UK would not have been in a position to supply a comparable system for at least another two years.

This prompted a fact-finding visit to Toronto in March 1963 by a UK team including both the authors of this article plus Arthur Jackson and Martin Wingstedt. Our brief was to study all aspects of the FP6000 - design, progress to date, availability of software, cost, maintenance and installation procedures - with a view to assessing the system's suitability, with modifications if necessary, for manufacture and marketing in the UK.

On our return, we wrote a report recommending the adoption of the FP6000 as the system to meet Ferranti's needs in the UK medium price range market.

One paragraph from that report summarises its findings: "There are certain facets of the system we do not like. However, were we to begin designing now a machine in the same price/performance range as the FP6000, we would have in some 18 months' time a system that would not be significantly better - if indeed it were any better - than the FP6000."

Very soon after the publication of the report, a joint ICT/Ferranti party, including Arthur Humphreys, "Echo" Organ and Tom Shepherd from ICT and Peter Hall and myself from Ferranti, paid a visit to New York and Toronto. The ICT representatives were impressed with what they saw, and the FP6000 became a strong rival to the RCA systems that ICT were interested in at the time.

One incident during that visit put the FP6000 ahead of the RCA systems on points for me. The travel arrangements for the trip had been made by ICT: when Peter Hall and I met at Heathrow we were speculating whether the party had been booked first class or economy. The answer was economy, but on returning to New York from Toronto Arthur Humphreys' first action was to get a secretary in ICT's New York office to upgrade the return flights to first class!

Derek Eldridge takes up the story... I rejoined Ferranti in 1962 after six years with IBM. I enjoyed my time there, and even made a small contribution to the new "SLT Series", named after the solid logic technology specially developed for what was to become the 360 Series. Nonetheless I had missed the atmosphere at Ferranti, including the inventiveness of the people and the feeling of being closer to the centre of the action.

Before rejoining, I needed reassurance that the rumoured merger of Ferranti and ICT would indeed take place. Hugh Devonald and Peter Hunt were able to get me that assurance.

It was not just a question of concern for the viability of Ferranti (though, as others have observed, the corporate motto "First into the Future" would in any publicly quoted company probably translate into "First into the Red"!). IBM was about to take a major gamble aimed at replacing virtually all its computers with a new and compatible range. If it succeeded, its competitors would require an imaginative response, financial strength and marketing muscle, and only the first of these was assured within Ferranti.

The concept of a compatible range seems obvious now. It certainly wasn't then: the development, launch and marketing of just one new machine was a formidable enough venture. Large car manufacturers today still adopt this approach: they simply could not take the risk of obsoleting their entire product line in one go. So I did not find it easy to convince people that a response to IBM with a compatible range of our own was necessary, and that we did not have much time to develop such a response.

Few people had foreseen either the enormous burden that software development would become or the huge investment that customers would make in their programs, and which they would want to preserve. (IBM had - that was the reason it took the gamble.) So I believed we had to act quickly, and to do that we needed a machine that was already in production, or at least close to it, which could form the basis of a range. There simply was not time to develop a new range from scratch, though the number of teams within Ferranti, ICT and RCA which were looking for the "ultimate solution" was amazing.

The ability to deliver proven hardware quickly was thus very important. I believe this was the key factor in the decision to select the FP6000 as the basis of the range. This decision in turn must have hastened the ICT/Ferranti merger.

In the event, we did act quickly enough. The 1900 Series was announced in September 1964, only six months after IBM launched System/360. Several 1900 models were actually delivered earlier than their IBM equivalents, particularly in the UK.

The FP6000 was based on logic cards developed in Ferranti Wythenshawe for Orion 2. It incorporated many of the features essential for a third generation system, such as multiprogramming/timesharing and expandability, but had not been conceived as the basis for a range of machines.

There were a number of limitations to be overcome to make this possible: in particular we had to make order code changes to allow expansion of the memory capacity beyond 128K 6-bit characters. Ferranti had frequently used indirect addressing systems in its machines, and this experience led to the adoption of an extension of the "Datum and Limit" system in the FP6000, so that large memories could be addressed.

Later we added the concept of a standard peripheral interface to the 1900 (the FP6000 itself had a similar feature). The advantages of this, together with the communications facilities and the range of processors, became the main thrust of the marketing of the 1900 series, emphasising the interchangeability of all the boxes and therefore the ease of upgrading.

This concept of modularity was not entirely new. What we had not previously appreciated was the attraction to large companies of being able to install compatible configurations of different power in a number of sites, allowing some common software development as well as the flexibility of easy upgrading and site interchangeability.

Experience with Atlas in particular had shown the need for a richer operating system than could be provided by an "executive program", and one that met commercial as well as scientific needs. The first discussion of the requirements for such a system and its likely scope took place when Harry Goodman visited the Ferranti Planning Section at Bracknell in 1963.

Nobody at this stage envisaged the eventual expansion in the scope of what was to become George III - that was largely customer-driven. We also failed to foresee at that time the extensive growth in software required to support such a range.

The FP6000 with new software and an extended peripheral range became the ICT 1904. It was also offered in scientific form with a floating point unit as the 1905. More powerful machines - the 1906 and its scientific equivalent, the 1907 - were planned and included in the launch announcement, both also running, naturally, the George III operating system.

Stretching machines upwards in this way was difficult and pushed the limits of the contemporary technology. Expanding the range downwards proved even more difficult, because of cost constraints. However design sessions with Charlie Portman at West Gorton led to the conclusion that smaller machines were possible. Management decided to allocate them to the Stevenage factory, which did a remarkable job of achieving the objectives set within a very short development timescale. To our surprise it even became possible later to extend the range further downwards still and produce what became the 1901.

There were many hiccoughs on the way, not least in fighting off alternatives to the 1900 series which management considered, and there were many of them. Some failed the criterion of early availability. The strongest alternative was to copy the IBM range (when we found out what it was), and many visits were made to RCA to evaluate the Spectra 70 range before, during and after the initial 1900 development.

This option was ultimately rejected for marketing reasons: we would always be offering delayed copies of products defined by IBM rather than by ourselves. We also took advantage of the fact that we were closer to the European market, whose needs would be significantly different from those envisaged by IBM for a worldwide market.

In the event we had a major piece of luck - the long delivery periods announced by IBM. That gave us a delivery advantage to add to the cost advantage inherent in a 6-bit design based on proven hardware.

The 1900 Series was very successful, partly because of our rigorous adherence to the principle of compatibility across the range, and partly because of its long life via various enhancements, including the A series (which incorporated integrated circuits for the first time) and later the S and T series.

All good things come to an end, though. Some features of the 1900 series, such as the 6-bit characters, which had helped greatly in reducing costs, became eventually unable to meet growing communications and storage needs. A "new range" had to come, and it appeared as the 2900 series in 1974.

But with the introduction of DME (Direct Machine Emulation) in 1977, the 2900 series could continue to run 1900 software. Indeed, both 1900 hardware and software still run today.

Editor's note: this is an edited version of a joint presentation made by the authors to the Society as part of the ICT/ICL 1900 seminar held at the Science Museum on 30 May 1996.

Early Computer Developments at EMI

Ron Clayden

Members of the Computer Conservation Society have been given many presentations on the early work on Edsac, the Leo and Ferranti computers and the Ace Pilot model. In contrast, little attention has been paid to the early work at EMI. This article attempts to redress the balance.

There were a number of influential engineers at EMI Research Laboratories (EMIRL) at Hayes, Middlesex, who contributed to the early development of electronic digital computers. They included Ted Newman, who moved from EMIRL to the National Physical Laboratory (NPL) to join the team working on the Ace Pilot model computer. David Clayden later followed the same route, and later still I also left EMIRL to join the English Electric team working at NPL. All three of us had experience of television transmission equipment, especially TV cameras, amplifiers and pulse circuits.

When I joined English Electric I reported to Colin Haley at the Nelson Research Laboratories at Stafford, but I actually worked at the NPL at Teddington, Middlesex. My principal occupation was the preparation of circuit diagrams for the Ace Pilot, which I then sent to Stafford for use in the construction of the English Electric Deuce computer.

When I had completed this task, but before Deuce was fully working, I replied to an advertisement by EMI Electronics for a television camera engineer. At the subsequent interview I found that the company was also looking for an engineer with experience of computers. I duly became the first engineer of the EMI Electronics team in October 1954.

Initially I reported to Dick Booth at Feltham. We moved later to Hayes, and I was joined there by Derek Hemy and later by John Grover, both from the Leo team. Hemy was a programmer who sketched out the Instruction Code for the EMI Electronic Business Machine, as our computer was to become known.

Other key members of the EMI Electronics team included Bob Froggat, who joined us from the company's Study Group at quite an early stage, and with David Robinson formed the Logic Design section. Bill Ferrier also joined us from Birkbeck College, where he had worked on computers under Dr AD Booth.

My starting brief was to produce a computer quickly using known techniques. I had some experience of mercury delay lines working in a machine with a clock rate of 1MHz, but I decided to use a magnetic drum store, as this would provide much higher capacity using straightforward techniques, albeit at a somewhat lower clock frequency.

Initially we started to build a simple machine to prove the techniques, known as CP401 (for Commercial Project 401). Before it was working we received a firm order from the British Motor Corporation for a computer to process its payroll. This machine proved to be the first and only EMI Electronic Business Machine produced: it was given the project number CP407, and was also known more colloquially as the BMC Payroll Computer.

The commitment to BMC led to a great expansion of our team and also to a devolution of some of the work to other parts of EMI Electronics. The magnetic drum and the tape decks were developed at Wells in Somerset by a team initially under the direction of Willi Luttmer. Another team at Hayes, led by Godfrey Hounsfield, was responsible for the circuits associated with the Powers-Samas punched card readers and the Samastronic line printer. I was responsible for coordinating all the teams.

Readers who want all the details of the logic design of the EMI Electronic Business Machine and its principal parameters are recommended to refer to the paper presented by Bob Froggatt at the Conference on Electronics in Automation at Kings College, Cambridge on 27 June 1957[1] . The major details are as follows.

The storage system was a non-ferrous drum coated with a magnetic suspension. The drum was 8 inches (203mm) in diameter and about 8 inches long. It rotated at 3000 revolutions per minute.

Main storage consisted of two banks of eight recording heads moveable to eight positions and thus capable of recording 64 tracks per bank, and one bank of 16 heads moveable to 16 positions for a further 256 tracks. So there was a total of 384 tracks. Each could store 64 words recorded by phase modulation. The word length was 36 bits, or six times six characters, so total main storage capacity was 24,576 words, 147,456 characters or 884,736 bits.

In addition the drum had 50 circulating registers. These were achieved by means of a writing head and a reading head spaced one word length apart on the drum surface, together with the associated amplifiers and other electronic equipment.

[1] "Logical Design of a Computer for Business Use" by RJ Froggatt, Journal Brit.IRE December 1957, pp 681-696.

There was also a Quick Access Track. This can be considered as one read/write head and 63 read heads on one track of the drum. With 64 words to a track the total access time for writing was about 200 milliseconds, but for reading only 3 ms.

The drum had two ancillary tracks: a clock track and a pulse per revolution track.

The computer used approximately 2000 valves, which were mainly double triodes. Magnetic core/transistor circuits were used in the input/output buffer circuits and for the circuits associated with the peripheral units.

Input and output peripherals comprised two Powers-Samas punched card readers and a 300 lines per minute Samastronic printer. There were also five magnetic tape units, which stored information serially in eight word blocks at a digit rate of 2 KHz.

The EMI Electronic Business Machine, or CP407, was installed at the BMC factory at Longbridge, Birmingham, and was programmed to process the payroll for 20,000 employees. The BMC house magazine for June 1961 reported, "It was the first electronic computer installed in England making full use of magnetic tapes and drum for memory, thereby enabling all the required final data to be obtained from one single processing of a departmental pay unit.

"As it stands now, with 100% of the hourly paid employees' payroll being calculated on it, nobody is doing a more comprehensive job on a computer.

"EMI later provided a second computer now installed for sales work and production programming"[2] .

The BMC computer was the only EMI Electronic Business Machine produced because electronic development had reached a stage where transistors were becoming useful and available, and valve technology was becoming obsolete.

This was mainly because of valve failure rates. If you assume a failure rate of 0.1% per 1000 hours, a machine with 2000 valves would on average break down every 500 hours. This was bad enough in itself, but while searching for the defective valve a second could fail, and even a third. That would lead to considerable machine downtime while the faults were found and rectified.

[2] BMC World, Longbridge edition, June 1961 pp6, 7 & 10.

Valves simply lost emission. When a defective valve was removed, we found it could pass the required current only with the grid positive to the cathode. We used a circuit technique which partly mitigated the effect of loss of emission. But when transistors became reliable and useful, they seemed to be the better active components to use.

When the EMI Electronic Business Machine was installed at Longbridge, the technical literature still had to be completed. I was given this task, while Bill Ferrier looked after the BMC installation and Godfrey Hounsfield started development of the Emidec 1100 computer.

While we were still working on the EMI Electronic Business Machine the company won a contract from NRDC to develop a transistor-based computer: this work came to fruition in the Emidec 2400. The team was led by Charles Kramskoy and included Norman Brown and Bill Talbot. Later I took control of this project, while Charles Kramskoy became EMI Electronics Chief Engineer. Around the same time, Norman Hill joined us from Elliotts as Sales Manager for computers: he was responsible for the sales of nearly all the Emidec 1100s and 2400s.

Not long afterwards the whole of EMI Electronics computer development was taken over by NG Partridge, and the EMI Electronic Business Machine team split up. I moved to military development, where I was responsible for the Optical Line Scan project for the TSR2 aircraft. Derek Hemy, John Grover, Norman Brown and Bill Talbot all joined ICL, while Bob Froggatt became an Assistant Director in EMIRL. Godfrey Hounsfield also moved to EMIRL, where he developed his prize-winning brain scanner. Bill Ferrier remained in EMI Electronics, working in the Automation Division initially before moving to Wells, where he worked on a railway ticketing machine.

I last saw the magnetic drum of the EMI Electronic Business Machine in the Birmingham Museum of Science and Industry. It was languishing forlornly among a cluster of items labelled acknowledging Dr AD Booth, with no information about what it was, where it had come from or who had designed and made it. I have suggested that the drum should be moved to the Science Museum or to Bletchley Park.

I should like to take this opportunity to express my appreciation of the team, and especially to thank Derek Hemy, Bob Froggatt and Bill Ferrier for the parts they played.

Book Reviews

Nicholas Enticknap, Editor

User-Driven Innovation by David Caminer and others, 416pp hardback, published by McGraw Hill at £ 35.00 (ISBN 0-07-709236 8).

We carried in the previous issue of *Resurrection* articles by John Aris and Frank Land, discussing their experiences with the Leo computers built by J Lyons & Company. We recommend that readers who have enjoyed these articles and would like to know more about this unique pioneering exercise should get hold of a copy of this book.

User-Driven Innovation tells the story of the Leo computers marks I, II and III, covering the period from J Lyons' first contact with computers to its decision to pull out of computer manufacture 20 years later. Leo I was the world's first computer to be designed for business computing, and the only one to be designed by a user organisation. This gives the book its title, which reflects accurately the thrust of the content.

With this emphasis *User-Driven Innovation* is complementary to Peter Bird's book *Leo - The First Business Computer*, which was reviewed in *Resurrection* issue 10. Bird concentrated on the technical problems involved in constructing a computer: *User-Driven Innovation* focuses on the management and application issues.

As such, it is not a history in the conventional sense, though the editor, David Caminer, has written a chronological narrative which forms the first part of the book. The remaining 14 chapters - just over half the total - consist of reminiscences from 12 other people who were actively engaged in getting the Leo computers to work, and tell of the problems faced and of the methods devised to overcome them.

Some of these chapters describe the development of the early applications, others deal with the difficulty of establishing computers in South Africa and behind the Iron Curtain, while still others look at the procedures developed in the light of modern day practice.

David Caminer's sensitive editing ensures that these necessarily diverse memories form a coherent whole which is both readable, even by non-specialists, and thought-provoking. The excitement of tackling problems that had never been faced before is one consistent theme, as is the contrast between the approach of the Leo team and that of their competitors in the emerging computer market.

As Ninian Eadie says in his contribution, "In many ways Leo did then what IT companies would like customers to believe they do now - it sold business solutions". So this book can also provide much food for thought for today's computer executives - many of the problems they face are the same as those tackled by the pioneers of the fifties.

An ICL Anthology edited by Hamish Carmichael, 259pp paperback, published by Laidlaw Hicks Publishers at £ 10.00 (ISBN 0-9527389-0-2)

Most of the material published in *Resurrection* has a predominantly serious historical content, documenting the key moments and discoveries of the pioneering days through the eyes of those who created and witnessed them. There was of course a lighter side, which occasionally we touch upon. This book is devoted entirely to that lighter side.

It consists of anecdotes from the whole of ICL's history and prehistory, covering the most amusing and least successful moments in the lives of those who worked for British Tab, Elliott, English Electric, Ferranti, ICT, Leo Computers, Powers Samas and Singer as well as ICL itself.

Though woven into a harmonious whole by Hamish Carmichael's editing, the stories are told by those who were there at the time. As Carmichael himself observes, "ICL, though it always thought it was producing computers, has actually had its greatest success in producing raconteurs".

Many of the stories are essentially human ones, covering such everyday experiences as the perils of job interviews, the hazards of air travel, the problems when a demonstration goes wrong, the absence of deference to superiors, and ingenious methods of clinching the sale.

Technology does, naturally, enter in, though never obtrusively. The book will remind older readers, and enlighten younger ones, about the difficulties that punched card and paper tape equipment could cause, and the problems of getting early valve and transistor machines installed and working. Some of these stories have a happy ending, none more so than the one that describes how the performance of an ICL 1906A was improved by 27% by changing a single byte of code!

An ICL Anthology will bring back memories to every ICL employee with any length of service (and as Arthur Humphreys tells us in his Foreword, there are more than 15,000 who have worked for the company for over 21 years). Memories of places, of pioneering technology, and of personalities such as Humphreys himself and the likes of David Caminer, Geoff Cross, Mike Forrest and Brian O'Heron, to name but a handful.

Society Activity

North West Group

Frank Sumner, Chairman

The meetings for 1995-96 have been well attended. The presentations by Jack Howlett and Alan Bagshaw were particularly interesting to those of us who had been involved with the Atlas centres.

One of the few presentations we have had on software developments was given by Professor King. This covered the evolution of database software, and also contained a very interesting account of the use of database techniques in modern policing.

Gordon Scarrott[1] was unfortunately not well enough to travel to Manchester to give his talk in person, but he sent us the text and Charlie Portman made a superb job of delivering it.

The best attended presentation was by Chris Burton on the rebuilding of the first Manchester computer. This was held at the University to simplify the demonstration, and that allowed us to open the meeting to staff and students from the Department of Computer Science and the rest of the University. We also made contact with Stockport Grammar School, the old school of Professor Williams, and two teachers and several students were able to attend. In all there were about 80 in the audience, and the meeting was a great success. The contact with Stockport has been maintained both by the CCS and the Museum (by Jenny Wetton) and it will be involved in the 1998 celebrations.

The CCS is represented on the University Committee planning for 1998 and of course on the committee concerned with supporting the rebuild of the 1948 machine. Progress on this is going extremely well. The system is being assembled in the main computer room of the University, and as it is positioned close to the glass wall of the viewing gallery its steady growth can be seen by the many people who walk past every day.

ICL is being very supportive, and the latest addition to Chris Burton's team is Tom Hinchcliffe following his retirement from working full time for ICL. Tom is looking forward to helping with the commissioning phase which is expected to start at the beginning of 1997. Tom is remaining on the two committees mentioned above, which will be a great help in working with ICL and also with the City of Manchester which is still very keen to be involved with 1998.

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[1] *Editor's note:* I regret to have to record that Gordon Scarrott has died since Professor Sumner wrote this report: see page 3.

London Pegasus Working Party

Chris Burton, Chairman

The announcement that the Science Museum would embark on a major building programme for the millennium resulted in urgent consultations regarding the fate of Pegasus, because the Old Canteen is now scheduled to be demolished within months. It is now planned to store and operate the machine temporarily at Blythe House before returning it to South Kensington in order to place it, in working order, on public display in a new gallery. A working party meeting was held to disconnect the main parts of the machine from each other, an operation which was carefully recorded. The machine has now been moved to the site at Blythe Road. It is intended to re-connect it and maintain it there so that our collective skills are retained.

Elliott 401 Working Party

Chris Burton, Chairman

A working party meeting was held in early October to supervise the movement of the Elliott 401 from its holding store into the pleasant room F48, with a carpeted false floor and adequate electrical provision. All the cabinets were placed in position on the plinth, the first view we have had of the imposing system since it was last dismantled over 30 years ago. We looked again at the documentation to remind ourselves of where we had last reached (some two years past!) and will now think about what we should be doing next to restore the machine.

Small-Scale Experimental Machine

Chris Burton

The rebuild project team has been very busy over the last few months, analysing photos and circuits, producing CAD drawings, having metalwork made and actually wiring up chassis. Now that the seven Post Office racks are in place with many chassis fitted, the machine is beginning to resemble the famous photographs. The power system is in place and working, and the "typewriter" (a panel of push buttons) with its associated rack of pulse generators has been largely commissioned. Some of the vertical deflection chassis are working, and the timing circuits are nearly working offline.

We have a target to complete all the construction work by Christmas, leaving all next year to make the machine work. There is still a lot to do by the goal date of 21 June 1998, a date we will not be able to persuade Marketing to postpone!

Interest in the project remains high, with visits by Sir Brian Flowers, Chancellor of Manchester University, and by media people. We are grateful to many people who have donated components and help, and not least to the people in the workshop at ICL who enjoy making old technology for us, dimensioned in feet and inches rather than millimetres.

Editorial fax number

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

FTP, Web and E-mail Addresses

The Society has just acquired 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** mentioned in the past two issues of *Resurrection*. The pages of information at our Web site are still in the early stages of construction, but already include new information about the SSEM rebuild project as well as selected papers from *Resurrection*. Full access to the FTP archive is also available for downloading files, including the current and all past issues of *Resurrection* and simulators for historic machines. Many thanks to North West Group member Adrian Cornforth, who created our Web pages.

Many readers will also be interested in WWW sites run by other bodies concerned with the history of information technology. The Universal Resource Locators for a few of these organisations are as follows:

Bletchley Park (contains information on Colossus)
http://www.cranfield.ac.uk/CCC/BPark/

Manchester University (for its early computers)
http://www.cs.man.ac.uk/mark1/

Science Museum
http://www.nmsi.ac.uk/

National Archive for the History of Computing
http://www.man.ac.uk/Science_Engineering/CHSTM/nahc.htm

The Virtual Museum of Computing (a rich source of links to other computer history resources)
http://www.comlab.ox.ac.uk/archive/other/museums/computing.html

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Forthcoming Events

11-12 January 1997, 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}

4 February 1997 North West Group meeting jointly with BCS and IEE, 1745 hrs

"The Colossus Code-Breaker and the Colossus Rebuild", by Tony Sale

27 March 1997 London meeting, 1500 hrs

"The First Manchester Computer - its history and rebuild", by Chris Burton and Geoff Tootill

9 April 1997 London meeting jointly with Newcomen Society, 1745 hrs

"The Evolution of Methods of Construction, from Early Radio to Modern Computers" by John Pinkerton

April 1997 North West Group meeting, 1500 hrs

Afternoon/evening seminar on ICT/ICL 1900 series

The North West Group meeting on 4 February 1997 will be held in the Renold building at UMIST, while the 1900 seminar will be held on a date yet to be decided in the Manchester University Maths Department. The two London meetings will both take place at the Science Museum.

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

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