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 is thus covered by the Royal Charter and charitable status of the BCS.

The aims of the CCS are to

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

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

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

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

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

Resurrection

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Contents

Editorial

Nicholas Enticknap, Editor

Welcome to the latest issue of *Resurrection*, a bumper edition which equals our previous record issue size.

This is an exciting time for members of the Society and for all interested in the history of computing. We are approaching the fiftieth anniversary of the first time a program was run on a stored program computer: the jubilee will occur during the current lifetime of this issue of *Resurrection*, on 21 June 1998. A variety of events have been organised to mark the occasion, including a Golden Anniversary Conference in Manchester, and our newspapers and television screens are certain to be full of reminders of the breakthrough made in those far off postwar days.

The project to build a replica of the computer that ran that first program, the Small-Scale Experimental Machine or "Baby", is proceeding according to plan, as project leader Chris Burton reports on page 38. The other CCS rebuild project, of a Bletchley Park Bombe, started more recently but work is well under way here too, as John Harper describes later in the same section.

Also since the last issue there has been a full programme of meetings in both London and Manchester, which we expect to feature in future issues. London seminars covered the history of the software industry and of the NCC, while North West Group members have heard about early developments in computer graphics and in process control, and more recently an account of early computing developments in the former Soviet Union.

For our feature articles in this issue we turn to earlier meetings. Our first article is different from many we have carried in that it dates from the 1970s but still describes a ground-breaking endeavour. This is Unilever's attempt to apply computers to the task of word processing, one of the first completely new applications enabled by computers. Then we continue our emphasis on pioneering work outside the UK with the second of our features on Chinese computing. The third article is on a more conventional theme, the product planning of the ICT 1900: it provides a valuable insider's view of how ICT and then ICL kept pace with IBM in both technological and marketing terms despite having only a fraction of the resources.

News Round-Up

Chris Burton is to receive an honorary degree from the University of Manchester for his work in creating the replica Small-Scale Experimental Machine.

- 101010101 -

The construction of the SSEM also attracted the attention of the BBC 9 o'clock news on 30 December 1997. The coverage featured interviews with Chris Burton and also Professor Tom Kilburn.

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Officers of the North West Group of the Society are planning to publicise details of NWG meetings by e-mail in future. Members who would like to be advised of forthcoming NWG events in this way should contact Ben Gunn with their e-mail addresses.

- 101010101 -

Quite a number of members of the Society have moved address recently without notifying the Secretary. Such members may believe that notifying the BCS of their moves is enough to get their records updated on the CCS list as well. This is not the case: the CCS membership is held separately. This is because only a few members of the BCS are members of the CCS, while only around half of CCS members are also members of the BCS. So will any member changing address please remember to notify Hamish Carmichael.

- 101010101 -

Maxwell Burnet of the DEC User Group in Australia has included a flattering mention of the CCS in a recent edition of *inDECUS*, the Group's magazine.

A Distributed Array Processor (Mildap) together with its host Perq computer has been acquired in Manchester. We are very anxious to get this unique system working with demonstration programs, and anyone with knowledge and expertise to offer is invited to contact the North West Group of the Society.

- 101010101 -

While on the subject of acquisitions, several members have written to us enquiring what the procedure is when historical computers become available. The Committee of the Society has just formulated a policy statement concerning procedures for dealing with any such computers that come to the Society's attention. This is published in full below.

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CCS Collection Policy

1. The Society has no Collection of its own, and no premises in which to house one. There is no intention to change this.
2. When the Society hears of historic equipment which is becoming available for conservation, it will attempt to find a suitable home for it in one of the following major collections:
   - The Bletchley Park Museum Trust
   - The Science Museum, South Kensington
   - The Museum of Science and Industry, Manchester
3. The Society will also alert other collections to the availability of surplus equipment, where the major collections are unable to offer to house it, if it fits the appropriate area of interest. Members who know of such collections are asked to ensure that the Secretary is aware of their location and subject matter.

The Unicom Project

Peter Hall

The use of computers for word processing started in the 1970s and had become established by the time the IBM PC arrived in 1981. In this article the author describes one of the pioneering word processing systems, Unicom, which was developed by the giant Unilever combine.

The Unicom story begins in the early seventies in Unilever's head office complex on the Thames Embankment, where there were eight typing pools in four buildings. A typical pool had between eight and 17 typists plus a supervisor. Electric typewriters were standard.

Cultural changes in the late sixties had begun to cause management problems with this set-up. Wages were rising, and staff turnover increasing. It was becoming difficult to recruit suitably qualified and motivated staff, and it took time to train new staff to the required skill levels.

These factors were making it difficult to maintain service standards. Unilever was having to take on staff with lower qualifications than before, and that in turn made it necessary to raise the productivity of staff with these lesser skills if the standards of service to clients were to be maintained.

Unilever had its own internal business consultancy, the Organisation Division, which had evolved over the years out of what was originally a work study group. This organisation had conducted a number of studies which led to the idea of using computers to assist the typing process. The outcome was the Unicom project, which started at the end of 1971.

The Unicom project — Unicom was short for Unilever Communications — proposed that visual display units should replace the typewriters in the typing pools. Printing would become a separate operation, with its own dedicated operator. Both VDUs and printers were to be under computer control, with discs being used for document storage. There would be separate systems for each typing pool, with a communications link for inter-system document transfer. The intention was that at a later stage, stand alone VDUs with their own printers would be given to secretaries.

The hardware envisaged at this planning stage was typical of the period. The VDUs were to have 2000 character screens (25 lines of 80 upper and lower case characters) with a typewriter-style keyboard. Draft

output would be printed on line printers using continuous stationery and operating at 150 or 300 lines per minute, while finished documents would be produced on 15 cps serial printers using golfball heads.

The computer would be a 16-bit mini, with 32K words (64Kb) of core memory. It would have at least two disc drives which used cartridges (known as disc packs at the time) capable of storing 2.4Mb. The platters used in the packs had the then standard 14" diameter.

The Organisation Division drew up a list of requirements the system must fulfil. In total there were 10 of these, as follows.

- The system would be managed by the supervisor, who would control the workflow through the system and carry out all the housekeeping tasks. Access to the system's supervisory facilities would be password-controlled.
- Basic security features would be provided to determine who had access to which documents, and to provide security against loss of documents.
- Offline disc storage would be used: this was necessary for long term retention of documents (remember that the capacity of each disc cartridge was only 2.4Mb) and for security.
- One or two operators would be dedicated to the printing operations, including loading and unloading of stationery.
- The system would incorporate strong typing productivity features to reduce unproductive time, speed up typing and minimise rework. Ease of use was considered paramount.
- The system would be able to handle a wide range of document sizes, from A5 to double A4, and both single and multi-part sets.
- The system would be able to cope with preprinted forms and stationery (the typing pools were handling over 100 varieties of letterheads, memos and forms from both internal and external organisations).
- The system should support between eight and 16 VDUs (the system should be cost-effective with only eight typists, while typing pools did not exceed 16 staff).

- The system should support up to four printers (with a large pool there was a requirement for two quality printers, one draft printer and one spare).
- Working conditions should be good: the typing environment should be quiet, with the typists in a separate room from the computer and the printers.

On top of these system requirements, it was deemed essential for general acceptance that everyone should benefit from the new system — management, clients and typists. The benefits expected from the Unicom system were as follows.

For management:

- improved typing efficiency, and therefore a reduced establishment
- reduced staff turnover and so lower training costs
- faster in-site communication, and so reduced internal mail
- direct output to telex for external communication

For clients:

- quicker turnaround of drafts and amendments
- elimination of complete retypes, and so less checking
- high quality, error free final print
- the ability to produce personalised standard letters, with each one being a top copy

For typists:

- elimination of paper, carbon and ribbon handling
- simplified error correction (no rubbing out or tippexing, a big gain especially with multi-part sets)
- major amendments simplified (no complete retypes)
- simplified forms tabbing (tabbing through fields would replace manipulation of the typewriter carriage)

After the initial studies, Unilever management accepted that there would be considerable cost savings from Unicom, resulting from the reduction in staff and the organisational changes. The improvement in typing productivity was estimated at between 50% and 100%.

So a formal work study was undertaken over two months in mid-1972. It included all eight typing pools in terms of their total throughput of all types of work. Four of them were also selected for detailed work measurement analysis.

The detailed analysis showed that a typist took typically 87 minutes for a seven page report using a typewriter, but only 66 minutes using Unicom. To that had to be added 10 minutes for printing, but the operator was only busy for three minutes of that time, and so could be attending to other printers for the remaining seven minutes.

This kind of analysis was made for five major classes of work — tabulations, reports, letters and memos, preprinted forms, and standard letters. The average percentage saving in time made for each was 33%, 22%, 29%, 31% and 30% respectively — in essence, around a third of the time in each case.

These estimated time savings were then translated into staff savings. The study group found that the current 97 typists could be reduced to 67: adding in the printer operators brought the total required for the Unicom system to 78, a net saving of 19 people. This was actually less than the 25 people originally estimated, and was regarded as a conservative estimate at the time.

If supervisors were included, the final staff saving was 22 from a total of 105, or 21%.

This information was then used to arrive at a project costing. The project proposed four distinct phases:

1. for demonstration only, involving acquisition of a computer, one VDU and one printer and writing of just enough software to show the principles;

2. a development system, with seven VDUs and three printers, and running multi-user software;

3. the first typing pool system, with 32K word computer, 15 VDUs and four printers;

4. a full complement of five typing pools, involving four more systems with 14 VDUs and five printers each.

Direct costs were estimated at £11,500 for phase 1, £18,500 for phase 2, £37,000 for phase 3 and £157,000 for phase 4, adding up to a total of £224,000. These costs assumed the equipment used in phases 1 and 2 would be rented, but for phases 3 and 4 would be purchased at bulk discount prices. The computers were assumed to be Digital Equipment PDP-11 minis.

On top of these hardware costs, there would be a £74,000 development bill for the software. Subsequent running costs were put at £15,000 per year.

Against those costs, savings from the reduction in staff numbers and the release of eight rented magnetic tape typewriters were estimated at £40,000 per year.

All of this data was used to prepare a cash flow forecast. The results did not present a very favourable picture for Unicom, as on the most optimistic forecast it would take at least eight years for the cost to be recovered.

So the Organisation Division concluded it could not recommend to management that the project should proceed. Nonetheless, management decided to go ahead on the basis of the unquantifiable benefits, which included:

- easier recruitment and retention of skilled typists;
- higher quality of work, with quicker turnaround;
- improved working conditions; and
- the potential for inter-site communications.

At this point the project took off for real. Phase 1 — a single user model — was demonstrated in April 1973. This used mock-up software designed solely to demonstrate the principles.

Meanwhile, a detailed user specification was prepared in collaboration with the typing pool supervisors. This was completed in July 1973, when requests to tender were placed with around a dozen suppliers, including IBM.

Unilever was ready to place contracts by November. The companies chosen were Logica for the software and Raytheon Cossor for the hardware. The Raytheon PTS-100 was an unusual choice: it was essentially an enhanced IBM 3270 look-alike clustered terminal system. An important plus point was the low cost of add-on VDUs.

The prototype system configuration was delivered in mid-1974. At its heart was a Raytheon PTS-100 16-bit mini with 32K words (64Kb) of 1.6 microsecond core memory, dual ported for screen refresh (at 70Hz) and program execution. It was programmed in assembler, and the programs were loaded via paper tape. Because core memory was non-volatile, the programs remained in memory when the computer was switched off.

The VDUs were monitors only; they had no memory of their own, 2Kb being allocated to each one within the computer's core memory. They displayed 24 lines of 80 characters each. The characters, which included upper and lower case, were constructed from a 7x9 matrix.

The PTS-100 had four IBM 2314-compatible disc drives, which wrote to 2.4Mb 14" disc cartridges. Three of them were viewed logically as a single disc, while the fourth was used for overflow, disc tidying, and offline storage. Documents were stored in two separate files, one for the text and the other for formatting information. They were stored in compressed form and in random sector sequence for maximum disc utilisation.

The printers for quality output were made by Diablo and printed using a daisy wheel at a speed of 30 characters per second. They had both roller and tractor feed, a 13.2" platen, and could print at 10 or 12 pitch. The printers for drafts were ICL Termiprinters, which operated at 180 characters per second and had tractor feed only.

The system was controlled by a supervisor, who had a VDU for monitoring all the other screens; she could log on to any of those screens using her password. Her duties included running the disc tidying routine (which among other things automatically deleted jobs that had been printed unless explicitly marked for saving) and printing the document index, both daily; and running a utility for reconstructing files if a disc failed.

The print operator also had a VDU; this provided an active display of all printers and print queues. The queue information listed the paper or form type required, the number of pages and the job priority.

It is instructive, looking back, to see how much this prototype system could do with a capacity that would now be regarded as totally inadequate for a single user desktop computer. The response to normal typing speeds was quite adequate unless several typists were simultaneously and continuously scrolling.

Before installing this prototype system, Unilever conducted another work measurement exercise. This, which was much simpler than the first, was designed to compare the amount of effort involved in new work with

that in error correction and retyping.

The study found that typists only spent around a quarter of their time at best in typing new words. Retyping took 15% to 20% of the time and error correction 20% to 25% — in combination almost twice as much. The remaining time was spent on paper handling (5% to 10%) and idle time (30%).

Similar measurements were made after the prototype system was fully commissioned and the typists fully trained in its use, and this demonstrated the value of Unicom most convincingly. Indeed, the improvements in productivity were far better than expected. The proportion of time spent typing new words more than doubled, to 60% or 65%, while the time spent retyping or moving words and in error correction fell to just 10% (the idle time remained the same).

This demonstrable success of the prototype system led to the rapid adoption of Unicom in Unilever's head office and also in other Unilever companies, including UCSL (the computer bureau).

By 1976 Unilever was in a position to evaluate the benefits gained from this widespread adoption of Unicom. They were much the same in kind as anticipated at the outset, though in most cases greater in degree.

The number of head office typing pools had been halved, and the total establishment reduced even more, from 105 to 49 (this had been achieved by natural wastage; there were no redundancies). This helped the cost justification, which was also made easier by rapid wage inflation in the period following the 1973-74 oil crisis. The combined effect was to reduce the payback period from eight years to three — an added incentive to adopt the system.

Most of the other forecast benefits had been realised too. That is: the working environment was cleaner and quieter; longer rest periods had been introduced; annual staff turnover was greatly reduced; work turnaround was faster; the standard of completed work was higher; and the supervisors enjoyed improved control over the work.

There were some problems. There were complaints about the reliability of the system, and the lack of standby facilities. The entry price was seen as high, and some departments would have preferred standalone terminals. And Unicom did not tackle the secretarial problem.

Nonetheless, overall Unicom was a success. Unilever's two computer industry partners, Raytheon Cossor and Logica, had both installed Unicom systems in their own headquarters buildings, while other companies were

becoming interested, notably Shell.

This raised the question of marketing. Unilever was keen to promote Unicom within its own subsidiaries, but had no interest in selling the system on the open market. Accordingly, it pursued a policy of granting marketing licences to other companies.

UCSL was given a sales and support licence covering all UK Unilever subsidiaries, and Logica a similar licence for all other UK companies — this included the right to undertake its own development. Logica formed a new subsidiary, Logic VTS, to undertake this work.

Outside the UK, the Danish company DI Datanet was granted a sales and support licence for Scandinavia and some other European countries, notably Germany and the Netherlands. Towards the end of 1977, Cossor's parent Raytheon was negotiating a marketing licence for the USA and other overseas territories. This was expected to generate a lot of business from the hundreds of PTS-100 installations.

But competitors were beginning to emerge. Initially they were clustered systems like Unicom, but with the arrival of the microprocessor some firms were beginning to develop standalone word processors.

There were four major competitors in the UK clustered system market by 1976. Wordplex, a Canadian company, had a mediocre product but a strong marketing operation. Wang had the best software, which it offered on a special version of the VS series of computers. Basic Four marketed a four station cluster (it was available in the UK via Business Data Products Ltd). IBM was marketing an early version of Profs on its mainframes. There were others, less prominent.

Around a year later the first standalone machines appeared. Two more Canadian companies were among the pioneers: AES (which later merged with Wordplex) and Micom, which had the best software (this company was eventually acquired by Philips). Xerox entered the field a little later with an advanced system that featured a full A4 screen and Ethernet connectivity.

The major competitive considerations at the time centred on the following qualities: cost, both overall and entry-level; the maximum number of screens supported; display quality; the maximum online disc capacity; and system security.

Most vendors offered a variety of other features, and this led to the "ticking boxes" syndrome — the tendency to judge merit on the basis of the number of special features, whether or not they were essential. Typically

80% of the features of any system were used less than 20% of the time.

Unicom did not score well on special features. Where it was demonstrably superior to all the opposition was in system management; in ease of use; in forms and proforma typing and printing capability; in scrolling; and in automatic pagination.

Every vendor naturally claimed ease of use, but with the majority of products it was simply not true. Some offerings were based on programmers' text editors, which were usually clumsy and difficult for a typist to learn. Many also required the typist to set up the printing parameters for each job. Unicom scored heavily over these systems: it was possible to employ temps "off the street" and have them working usefully within half an hour, with the aid of minimum instruction and a thin user manual.

Nonetheless the many special features offered by the competition were causing marketing difficulties, even to some Unilever companies. A development program was planned for 1977-78 to add some of the features trumpeted by the competition.

Among typing facilities, they included: sideways scrolling (for wide pages); inter-job block text transfer; and multiple print queues for job batching.

Secretarial facilities to be added included: name and password access; local or remote printing; and the ability to display a document index.

Computer developments planned included: a doubling of memory size to 64K words (though all of the additional capacity was to be allocated to the screens, leaving a maximum of 32K words for programs); a doubling of online disc capacity to 15Mb (by adopting 5Mb cartridges); and the provision of communications facilities (these had been planned from the outset but were not yet in place).

Enhancing Unicom was difficult for a number of architectural reasons. Memory addressing, file structure, disc sectoring, the 6-bit character set, and the memory and disc capacity limitations all restricted development.

But the worst problem was program generation. Unicom lacked a native assembler, so installing a new program involved the following long- winded procedure: convert code from coding sheets to punched cards; transport cards to an IBM site (UCSL Watford); assemble new program overnight and output to paper tape; transport paper tape back to Logica's London office; load and test new program. The whole cycle had to be repeated if any errors were found.

So even minor changes could take several months to implement. This problem was one of the main reasons for the eventual demise of Unicom.

Nonetheless, the planned developments plus many other minor improvements ensured that Unicom remained competitive for several years more. Ultimately, more than 60 systems were installed, with the last being completed in 1982.

These included 18 within Unilever itself, including systems in both Rotterdam and Hamburg. Six other systems were installed in continental Europe. Shell acquired 15 systems for its headquarters and regional UK offices. British Telecom had three, while there were around 20 installed in other UK organisations. Together, these systems supported over 700 screens.

The beginning of the end came as early as January 1978 when Raytheon decided against entering the word processing market, just as it was about to sign up for the Unicom marketing and support rights in the USA.

By this stage Logica was developing its own standalone system, retaining the look-and-feel of Unicom but adding the ability to work as a communicating terminal. The system was called VTS-100, and was based on Intel microprocessors. It was designed to overcome the limitations of Unicom, and incorporated several new features of which the most important was a native assembler. Others included a capability for handling fractions and mathematical and scientific characters; a file merge capability for standard letters; and proportional character spacing.

Unicom's prospects revived at the beginning of 1979 when the Labour Government formed Nexos to market British office products. Three way discussions began between the new company, Unilever and Logica, and after protracted negotiations Nexos was appointed sole distributor for both Unicom and for Logica's VTS-100.

Nexos felt that the VTS-100 was not sufficiently competitive in the general market for standalone word processors: for example it did not have records processing capability. So the company developed a specification for an enhanced version, to be called the Nexos 2200. In addition to its functional enhancements, the 2200 was considerably improved ergonomically and in appearance.

Nexos displayed the prototype 2200 at the Hanover Fair in April 1980. Volume sales started in 1981, while Nexos was still marketing Unicom.

Political events now played their part. By the end of 1981 the Government (now Conservative) was trying to dispose of Nexos via its National

Enterprise Board (NEB) agency. After complex negotiations involving DRI, Gestetner, ICL, Logica and Muirhead among other companies, the NEB sold all the Nexos 2200 assets to ICL, which subsequently marketed the product as the ICL 8800.

Shortly afterwards Nexos itself was wound up. Maintenance of Nexos products was assigned to Nexel, a management buyout. Nexel provided support for all Nexos products, including Unicom, until 1986.

During the Nexos fiasco, Unilever had tried to interest some other companies in developing Unicom further. They included Hewlett-Packard and Xionics, a British company which was at that time pioneering the development of networked systems. But there were no takers: Unicom was by then outdated, and it was neither practical nor cost-effective to transport the software to another machine or operating system.

The principal cause of the decline of dedicated word processing systems like Unicom was the microcomputer. By 1979 there were several low cost desktop machines based on the Intel 8080 and running the CP/M operating system. Word processing packages that ran on this platform were becoming available cheaply, with Wordstar leading the market.

The knockout blow was the introduction in 1981 of the IBM PC, with its 16-bit operating system. This led to the arrival of much more powerful word processing packages such as Microsoft Word and Wordperfect, and ultimately to desktop publishing packages.

Today, you can buy a cut down PC for about £600, with bubble jet printer, simple spreadsheet and database software, and a basic version of Wordperfect. But I think it is fair to say that no system has yet surpassed Unicom for its ease of use and powerful forms typing feature.

Editor's note: this is an edited version of the talk given by the author to the North West Group of the Society at the Museum of Science and Industry, Manchester, on 30 September 1997.

Early Chinese Computers

Qiangnan Sun

This article follows on from the one in the last issue of *Resurrection*, which charted the progress of China's computer industry from 1956 to date. Here the author describes the design and development of the major early Chinese computer systems.

Once the 12 year plan for scientific and technological development had been formulated in 1956, work started promptly. A preparatory committee was set up to organise the Institute of Computing Technology under Academia Sinica, and Professor Hua Luogeng was appointed its chairman. The Institute was established that same year in Beijing. It developed training courses for the professionals from academia and industry who were to develop our computers.

The first two industrial research institutes, the North China Institute of Computing Technology in Beijing and the East China Research Institute of Computing Technology in Shanghai, were both founded in 1958.

From 1957 to 1959, the first university computing courses were set up in Tsinghua University, Beijing University, Harbin Polytechnic University and Harbin Military Engineering Institute. Others quickly followed at Jiaotong University, Nanjing University, National Science and Technology University, Beijing Polytechnic University and Beijing Aeronautic and Astronautic Institute.

In 1957 a team of researchers and engineers was sent to the Soviet Union. The task of producing the first two vacuum tube computers began in the second half of that year, both modelled on Soviet systems.

The smaller system, the 103, was modelled on the Model M-3 small scale computer, and the larger one, the 104, on the BESM-II large-scale computer. The Institute of Computing Technology of Academia Sinica and the Beijing Wire Telecommunication Factory were responsible for this task. Many scientists and engineers from the first batch of computer research institutes, universities and the factory came together and worked together in Beijing. They were the pioneers in China's computer industry.

The trial production of the 103 computer began in November 1957, and a prototype was complete by the end of July 1958. Its longest time between failures was a mere eight hours.

Improving both quality and performance took quite a long time, but in December 1961, the 103 was put into small scale production. It was named the DJS-1 (the letters DJS are the initials of the Chinese words for "digital electronic computer").

The first production DJS-1 was installed at the Dalian Institute of Chemical Physics. It ran reliably: it was available for 600 hours a month on average. Production of the DJS-1 continued until the transistorised computer was launched: in all 36 were made.

The main electronic components of the DJS-1 computer were vacuum tubes and cuprous oxide rectifiers. Initially we used Soviet tubes: 6H8C triodes in the flip-flop and 6X4 pentodes in the gates. Before long we could produce these in our own electronic tube factory: we renamed them 6N8 and 6Z4 respectively.

The small cuprous oxide rectifiers were used in logic circuits to form AND and OR gates (the semiconductor diode was not available at that time). The cuprous oxide diode caused much trouble in the beginning owing to its imperfect characteristics, so we changed to a germanium diode later.

A vertical magnetic drum was used as the main memory. Because of the very long access time (10ms average), the average speed of the DJS-1 computer was merely 30 operations per second!

The technical specification of the DJS-1 was as follows:

Word length	30 bits (fixed point only)
No of instructions	64
Average speed	30 operations per second
Processor technology	over 700 vacuum tubes
	cuprous oxide diodes (later, germanium diodes)
Main memory	vertical magnetic drum (Ni-Co-P alloy
	plating), diameter 220 mm, capacity 1K words
Peripherals:	
- input	5-hole paper tape reader
- output	RFT-51 teletype
Area	40 square meters (three cabinets)

The trial production of the 104 computer started in May 1958, half a year later than the DJS-1, and the prototype was completed in September 1959. At this stage the product was renamed the DJS-2. Seven systems were produced before the transistorised computers came onto the market.

The DJS-2 used magnetic core as the main memory, and magnetic drums and tapes as external memory. Speed reached 10,000 operations per second. The system was so bulky that it needed a computer room of 200 square meters for DJS-2 itself and another room of the same size for the power supply.

The technical specification of the DJS-2 was as follows:

Word length	39 bits (floating point)
No of instructions	32
Average speed	10,000 operations per second
Processor technology	4200 vacuum tubes
	4000 diodes
Main memory	magnetic core, 2K words capacity, 10 microseconds access time
Peripherals:	
- external memory	two horizontal magnetic drums (magnetic paste coating), 4K words capacity each
	two 0.25" magnetic tape drives
- input	2-hole paper tape reader
- output	narrow line printer (15 characters per line)
Area	
- computer	200 square meters (22 cabinets)
- motor generators	200 square meters

After production of the DJS-1 started in 1961, attention was directed towards further improving the overall performance. The outcome was a revised model, named DJS-3, which went into production in 1963. New features include magnetic core main memory, improved logic circuits and the use of an opto-electronic paper tape reader for input. Speed improved to reach 3000 operations per second, theoretically 100 times faster than the DJS-1 though in practice it proved to be much more than that.

Progress in developing this machine was however slow. As a result only four DJS-3s were produced before the system was replaced by the new transistor computers.

After completing the trial production of DJS-1 and DJS-2, the team members dispersed throughout the country to their own offices and laboratories. They started researching, teaching and sometimes making computers. A number of vacuum tube computers was designed and constructed

by these pioneers, though none ever went into production. Two examples of large ones were:

- Computer Model 119, made by the Institute of Computing Technology of Academia Sinica in May 1964
- Computer Model J-501, made by the East China Research Institute of Computing Technology in October 1964.

The 119 and J-501 both had the same word length (44 bits) and the same speed (50,000 operations per second), and they both used magnetic core memory. The J-501 had double the memory capacity (8K words as against 4K for the 119) and a faster access time (5.4 microseconds compared to 6.0).

During the same 1963-64 timescale other research institutes and universities built vacuum tube computers of small and medium size. We can list them as follows:

- Model 113, Model 102 and Model 117 computers, made by the North China Institute of Computing Technology
- "Hongqi" ("Red Flag") small scale computer, made by Beijing University
- Model 901 small scale computer and Model 4001 medium scale computer, made by Harbin Military Engineering Institute
- Model 911 large scale computer, made by Tsinghua University.

The Arrival of Transistorised Computers

Although the task of developing a transistorised computer, the 109B, was assigned early in 1958, none was completed until 1965. The main obstacle was that the transistors needed were still at the stage of trial production in the late fifties and early sixties, and the quality problems had not yet been solved. So the transistor failure rate was too high to allow a computer to run stably.

A delegation of the Chinese Institute of Electronics (CIE) visited the UK at the end of 1961. Its report described the great potential and significance of semiconductor technology for computer construction, and put forward proposals for quickening the pace of developing transistorised computers.

Vacuum tube computers were finally replaced by transistorised computers in 1965, which is considered one of the milestones in China's computer history. In less than a year, five transistorised computers were launched one after another. Two years later in 1967, there was a second wave of development and a number of transistor computers with higher performance was introduced.

Some transistor computers of historic significance are as follows:

Model	Word Length (bits)	Main memory capacity (Kwords)	speed (mips)	number of systems produced	year of introduction
109B	32	8	0.09	1	1965
DJS-21	42	8-16	0.03	130	1965
441B II	40	8	0.02	20	1965
X-2	42	8-16	0.02	15	1965
DJS-5	21	2-4	0.006	16	1965
109C	48	32	0.115	2	1967
DJS-6	48	16-32	0.06	156	1967
DJS-7	21	4	0.0015	36	1967
DJS-8	48	32	0.28	26	1971

Notes: the DJS-21 was also known as the 121, the DJS-5 as the 112, the DJS-6 as the 108B, the DJS-7 as the 127 and the DJS-8 as the 320. The model 109B and 109C computers were manufactured by Academia Sinica; the others were produced by industry.

Development of the first of these computers, the 109B, started early in 1958, though as we have already seen it was not completed and put into use until June 1965. It was developed in the Institute of Computing Technology within Academia Sinica in cooperation with other research institutes. All the transistors used in the 109B were made in China, and as the quality of manufacture improved over the period, the 109B ran quite reliably. Its mean time between failure was 10 hours and its longest time between failures 44 hours 36 minutes. A compiler called BCY was developed for it at the same time.

The technical specification of the 109B was as follows:

Word length	32 bits
No of instructions	75
Average speed	90,000 instructions per second (fixed point)

	60,000 instructions per second (floating point)
Main memory	magnetic core, 2x4K words capacity
Peripherals:	
- external memory	two magnetic drums, 4K words capacity each
	two magnetic tape drives, 256K words each
- input	5/8 position optical paper tape reader
- output	line printer (7.5 lps, 75 characters per line)

When the 109B was nearing completion in 1964, development of the successor model, the 109C, started, based on the experiences gained with the 109B. The 109C was completed and brought into use in July 1967, but never went into production: only two systems were made, both in academic laboratories.

The 109C was larger and faster than the 109B. The word length was increased to 48 bits, and average speed went up to 115,000 instructions per second. In addition to the 32K word main memory, it had a semi-permanent memory of 6144 words and an index memory of 128 words. A software monitor was developed for it.

Four new transistorised computers were displayed for the first time at the National Exhibition of New Achievements in Advanced Technology, held in Beijing in 1966. The DJS-21, 441B, X-2 and DJS-5 were the brilliant results of the joint efforts of two research institutes, two universities and four factories. All were completed and put into production in 1965.

The DJS-21 was developed and manufactured by the Beijing Wire Telecommunication Factory with the cooperation of the North China Institute of Computing Technology. The design was finalised at the end of 1964 and the prototype machine completed by the end of the following year.

Logic circuit technology varied greatly in the first batch of transistor computers from industry. The DJS-21 used NOR circuit technology with great success; the 441B used isolating-blocking logic developed by its own engineers and comprising pulse-transformers and transistors; while the X-2 used the resistance-capacitance coupled flip-flop circuit which was transformed direct from the traditional vacuum tube logic circuit. After several years of competition between these various designs, the DJS-21's NOR circuit technology proved to be the best.

The DJS-21 was one of only two computers from the Initial Period to have a production run of over 100: the other was the DJS-6. In all 130

DJS-21s were made. Both computers were produced in the Beijing Wire Telecommunication Factory, the first computer factory in China.

Development of the 441B started in 1963 by the Harbin Military Engineering Institute, which later moved to Changsha and was renamed the National University of Defence Science and Technology. The prototype was completed in 1965, and production began at the Tianjin Computer Factory in 1966. A total of 20 441Bs was produced.

Development of the X-2 started in October 1963 by the East China Research Institute of Computing Technology in Shanghai, and was also completed in 1965. Production began at the Shanghai Computer Factory in 1966, and in all 15 were made.

The DJS-5 was designed jointly by Tsinghua University and the Beijing number 3 Computer Factory. It was completed in 1965, and put into production at the factory in 1966. The DJS-5 was the smallest and slowest of the first batch of transistor computers, but was the first China-made computer sent abroad.

The Beijing Wire Telecommunication Factory was the earliest computer manufacturer in China. From the late fifties through to the early eighties, it was the largest computer factory. After the DJS-21 it manufactured successively the DJS-6, DJS-7 and DJS-8, all of which used the same NOR circuit technology. Germanium transistors were used in the DJS-6 and DJS-7, and silicon transistors in the DJS-8.

The North China Institute of Computing Technology begun development of the DJS-6 (also known as the 108B) in 1965 in cooperation with the Beijing Wire Telecommunication Factory, which started production after completion of the prototype in 1967. This machine had the record production run of any general purpose computer in the Initial Period: 156 were made.

The DJS-7 (also known as the model 127) was a small serial computer using ultrasonic delay lines in the arithmetic unit as its registers. As a result the average speed was not high, but the machine was compact and could be packed into a desk-shaped cabinet. The delay lines worked reliably and stably: indeed, one of the DJS-7s set a record for high reliability and availability by working for seven years continuously without stopping and without a single fault.

The DJS-7 was developed during 1966-67 by the Beijing Wire Telecommunication Factory in cooperation with the Institute of Automation Technology, Academia Sinica. A feature was a vertical magnetic drum imple-

mented for the first time on the DJS-7.

The DJS-8 was like the DJS-6 developed jointly by the North China Institute of Computing Technology and the Beijing Wire Telecommunication Factory, and went into production in 1971: 26 were made. It was the first transistor computer to use silicon transistors in the logic circuitry. The word length was 48 bits, and its main memory capacity (32K words) and average speed (280,000 instructions per second) were the highest of the contemporary transistor computers.

Some specialised transistor computers were developed for industrial process control. The thermal power plants and chemical plants were among the earliest users. Two models, DJS-K1 and TQ-1, were developed simultaneously in Beijing and Shanghai during 1965-67. The DJS-K1 was made by the Beijing Wire Telecommunication Factory and was used in a power station in Beijing. The TQ-1 was made by the Shanghai Computer Factory and was used in a power station in Shanghai.

The early process control computers were not very effective, because of lack of experience, but were a good start. After professional engineers had been trained, better models were produced, including the JS-10, a very successful process control computer developed in Shanghai, which had a very large production run of 455.

Researchers and engineers were very inventive during the Initial Period. The researchers at Shanghai even developed a computer prototype using magnetic parametron as its logical element, which worked well.

Integrated Circuit Computers

Research and development of integrated circuit computers started in 1965, with production starting in the early seventies. All of the early models used small-scale ICs and magnetic core memory.

Two pilot models using ICs made in China were completed in 1971. The model 111 was developed by the Institute of Computing Technology of Academic Sinica. It was a general purpose computer with a 48-bit word length and a set of 62 instructions, and was configured with a 32K word magnetic core memory. Average speed reached 300,000 instructions per second.

The model 112, a much smaller machine, was developed by the North China Institute of Technology. Its word length was 17 bits, the core memory was 1K or 2K words, and the average speed 26,000 instructions per

second.

In 1973, two large scale IC computers were launched in Beijing and Shanghai. Both were 100% China-made, using locally manufactured ICs, devices and peripherals. Both had the same 48-bit word length: they had similar architectures, used the same sort of small scale integrated circuits, and operated at around the same 1 mips speed.

The DJS-11 (also known as the 150) was developed jointly by the Beijing Wire Telecommunication Factory and Beijing University in cooperation with a couple of users. It was provided with a large magnetic core memory of 128K words, so large it needed six big cabinets to house it (including two for the dedicated power supply). It needed that amount of space to hold what we would today describe as 768K bytes at that time!

Four DJS-11s were built by the Electronic Instrument Factory in Beijing University. The users were the computing centres of the petroleum industry and the geology industry, plus a meteorological bureau. In the petroleum industry computing centres, the DJS-11s worked 24 hours a day, 365 days a year in seismic data processing, and made major contributions to the discovery and exploitation of new oil fields. The last DJS-11 was in use until 1984 in the computer centre of Jianghan Oil Field.

As the integration level of the ICs was low, the DJS-11 took up a lot of space. It was housed in 25 cabinets of various sizes and contained 3082 printed circuit boards with nearly 60,000 IC chips, 8000 thick film circuits, 10,000 transistors and 50,000 diodes. A total of 24 peripherals were used with the system, including a magnetic disc pack.

The 655 (also known as the TQ-6) was developed by the East China Research Institute of Computing Technology and was manufactured by the Shanghai Computer Factory from 1974 onwards. A total of 15 655s were built for a wide range of users including nuclear industry, aerospace, hydraulic engineering and construction.

The Institute of Computing Technology of Academic Sinica developed two high performance IC computers. They were designed for experiment and were never put into production. They were the model 013, with an average speed of 2 Mflops, which was completed in 1976, and the model 757, completed in 1983. The 757 had a clock frequency of 8.2 MHz and an average speed of 10 Mflops for vector operations and 2.8 Mflops for scalar operations.

A notable decision made at the beginning of the Transformation Period was to develop ranges of computers of large, medium and small sizes. Task

forces for the accomplishment of these objectives were organised in 1973. The members of the task forces came from institutes, universities and factories all over the country.

The range of large computers was the DJS200 mainframe series; the range of medium-sized computers was the DJS100 minicomputer series; while the smaller computers comprised a variety of portable and desktop calculators. They were all planned and developed under the centralised control of the Ministry of Electronics Industry.

The DJS200 Series United Design Group was set up in February 1973 with members from over 15 organisations. Development started a month later. The base for the daily work of the task forces was the North China Institute of Computing Technology in Beijing.

From 1973 to 1981, four models of differing performance were completed and put into use. They were the DJS260, DJS240, DJS220 and DJS210. The word length of the DJS260 was 64 bits and of the other three 32 bits. They all used dual-in-line small-scale ICs. The two more powerful machines employed MOS memories, while core memories were still used in the DJS220 and DJS210.

The operating principles and advanced technology of the IBM 360 and 370 ranges were consulted and referred to, but the DJS200 series was not IBM-compatible. Task forces for the development of system software were organised at the same time. Details of the DJS200 series models are as follows:

Model	speed (Mflops)	number of systems produced	start date	completion date
DJS260	1	2	1973	Sep 1979
DJS240	0.4-0.5	3	1973	Jan 1980
DJS220	0.1-0.15	10	1973	Jan 1979
DJS210	0.05-0.07	5	1974	Mar 1979

The DJS100 Series United Design Group was set up in June 1973, and comprised Tsinghua University, Beijing number 3 Computer Factory, Tianjin Institute of Radio Technology and other organisations. Tsinghua University led the project.

There were more than 14 models in the DJS100 Series, all with 16-bit word length. The design of the first model, DJS130, was completed in

January 1974, and the prototype completed and appraised in the following August. Details of 14 of the DJS100 series models are as follows:

Model	no of systems produced	start date	completion date	main design organisation
DJS101	30		May 1980	East China Normal Univ
DJS110	15	Jul 1976	Oct 1977	Nanjing Aeronautics Inst
DJS112	25	1978	Sep 1979	East China Normal Univ
DJS112A	2		Jul 1981	Shaoguan Radio Factory
DJS120	18	Mar 1975	Jul 1975	Tianjin Inst of Radio Tech
DJS125	15		1975	Fudan Univ
DJS130	456	Jun 1973	Aug 1974	Tsinghua Univ
DJS131	>280	Jun 1973	Dec 1974	Shanghai No 13 Radio Factory
DJS132	4		Mar 1981	Tianjin Inst of Radio Tech
DJS135		1976	1979	Tianjin Inst of Radio Tech
DJS140	>10	Aug 1974	Aug 1975	Tsinghua Univ
DJS142	4	Aug 1979	1982	Tsinghua Univ
DJS152			1982	Shuzhou Radio Factory
DJS153			Jan 1982	Tianjin Inst of Radio Tech

DJS130 was the basic model. Its design followed that of the Data General Nova 1200, and it was built using small-scale ICs. DJS131 was similar, but used a different type of IC. Both were very successful.

Both smaller and larger models were developed based on the DJS130/131. The design of the DJS140 followed that of the Nova 840, which had dedicated floating point and multiply-divide functional units. Most of the DJS100 models still used magnetic core memory, but those developed in the early eighties began to use MOS memory. Production of these systems was not so successful, because of the arrival of the microcomputer which first appeared in China in the early eighties.

Editor's note: This article is based on the talk given by Professor Sun to the Society at Birkbeck College on 16 May 1996.

Keeping the 1900 Competitive

Virgilio Pasquali

The decision to produce the 1900 range presented ICT with a considerable challenge. The company had to develop all its 1900 systems in house — the external procurement route was no longer available.

ICT was at that time the number one supplier in the UK (the UK was probably the only company in the world where IBM was not the dominant supplier). To maintain credibility and market share, ICT had to have, and to keep competitive, a range of 1900 systems equivalent to the IBM 360 range. But, as we used to say proudly in those days, IBM R&D spend was greater than ICT total revenues.

ICT had boosted its computer development skills by the acquisition of the EMI computer team and the Ferranti Computer Department. That gave it skilled development groups in West Gorton (with Charlie Portman, Gordon Haley, Chris Burton, Keith Howker and many others from Atlas and Orion) and in Stevenage (with Mike Forrest, Bill Talbot, Norman Brown, Ron Feather and their teams). But we hardly knew each other, and certainly did not have a common development outlook and methods.

Having been involved from the beginning, I can say with certainty that the initial version of the 1900 did not suffer from the long and careful planning of the IBM 360. We did it in a hell of a rush! IBM's announcement gave us market space we exploited by acting quickly.

Some six months after IBM's announcement, on 28 September 1964, we were able to announce a range of seven 1900 system models, programming aids and peripherals. In 1965, the range was extended with a new entry level system, the 1901. Our major sales slogans were "value for money to the customers" and easy growth, and the systems were priced 5% below the IBM price/performance curve.

From a performance point of view, the 1900 range competed well with the lower part of the IBM 360 range and, with the arrival of the 1901, had a lower entry point. But we had some problems at the top end. IBM's top models, the 360/65 and /75, were significantly more powerful than our 1906 and 1907 systems. We wanted to be in the area of high performance commercial systems, with its prestigious customers and high profitability, and our shortfall here provided impetus for the development of multiprocessor systems and, eventually, "New Range".

Looking back, I never cease to be surprised that our engineers and programmers both maintained and improved the competitive position of 1900 relative to IBM, despite the massive difference in development resources available to the two companies. By the end of the 1900's lifetime in 1974, ICL (as it had then become) had improved the span of the range covered by single processor systems and was delivering the S and T series models using advanced designs with state of the art technology. We still priced our systems 5% below IBM to maintain the "value for money" sales argument.

In addition to maintaining the competitiveness of 1900, we had introduced the 2903 (a 1900-compatible system) below the bottom of the 1900 range to compete with the IBM System 3, and were well advanced in the development of the three top models of New Range. It is likely that, had we applied today's management and risk assessment techniques to the competitive challenge we were facing then, we would have concluded that what we were trying to do was impossible!

It is interesting to look back at some of the factors that were instrumental in achieving such a good result from our very limited resources.

First, speed of implementation. Although the 1900 architecture had a number of recognised shortcomings, it was very open and could be evolved quickly. The 1900 Executives were a major factor in this flexibility. They provided an interface between the hardware and the rest of the software, absorbing the changes and enhancements to the hardware and providing a stable compatible interface across the range throughout its life. So we were able to decouple hardware and software developments. The Executives also allowed us to deliver systems without waiting for the operating systems to be completed, and were a vital factor in allowing delivery of the first 1900s in 1965, before IBM had started shipping 360s.

Second, range compatibility was strictly adhered to, under the control of a Compatibility Committee chaired by Bruce Paterson. In principle at least, all the software ran on all the systems (given adequate system resources). This required rigorous discipline: there was a number of times when it was thought desirable to change a member of the range to improve its competitiveness in its market slot, but every such proposal was turned down even when this meant the product had to be abandoned.

Third, modularity. The ICT Standard Interface, specified by Ron Feather at Stevenage, was a major component of 1900. The concept was not new: standard peripheral interfaces began to appear in the early sixties. (I came across one for the first time when I was designing the magnetic

tape subsystem for Orion: Peter Hall, Manager of the Computer Department, insisted that the Ampex tape decks should be interfaced so as to be interchangeable between Atlas and Orion. Most unreasonable!)

In ICT we exploited the portability that the ICT Standard Interface gave us very strongly, both as a marketing tool and as an effort-saving tool in development. Very soon we developed other interfaces, such as the store-processor interface for the upper subrange, which allowed modular development, multiprocessors and the design of later enhancements.

The fourth factor was rapid application of technology. Technology was procured externally, which forced us to develop a good understanding of what was going on in the industry and what the technology trends were. We had access to the most up-to-date technologies, and our engineers learned to apply them very rapidly.

In addition to these technical factors, there were organisational factors that also contributed.

The first was that everybody worked together. When we needed to define a system, we would form a working party representing all interests (Planning, Marketing, Development) to tap all available expertise. A working party typically sat part time for two to three months. Between meetings, members returned to their units and consulted widely with all experts (for example, the development people might already be doing some pilot work on the new system and would input their initial experience).

The new system under consideration was defined by the working party in this way and then put to the Development Committee for approval. It worked well because we all knew we only had one shot: if a development was badly specified or for some reason failed to deliver the end system, it would leave a big hole in the range. We could not afford to have parallel competing developments for the same end system. (But West Gorton-Stevenage constructive competition kept the development up to the leading edge of technology.)

The working party mechanism was first used to specify the 1901 immediately after the 1900 range announcement. It worked so well that I continued to use that mechanism for all the new systems that I planned and defined up to 1968, when I moved out of Product Planning.

The working party mechanism was complemented by the rapid decision-making of the Development Committee. The definition of any system that emerged from the working party was given a market assessment and analysed in terms of proposed resource allocation, costs and profitability before

submission to the Development Committee, which was the final authority. It usually got approval within one week of submission, eliminating confusion and uncertainty. When a development was approved, all I needed was a few phone calls and the project hit the deck already running — all the members of the working party were back in senior positions in their teams, fully informed and committed to the project.

Another organisation factor was the focus on development. Only the 1900-specific system components got priority in the allocation of resources. Outside procurement of all non-essential subsystems — those not specific to the 1900 — became the norm.

From a development point of view, we can look at the 1900 range as having two different and distinct phases. The initial phase explored the limits of the architecture and established the shape of the range — during this phase there were no major changes in technology. The second phase was of rapid application of advanced technologies to the well bedded, stable and understood architecture.

Immediately after the September 1964 announcement we started planning the 1901. At the time, conventional wisdom held that you had to have good character processing in that type of machine, but 1900 had hardly any in the order code, being a binary machine, and we could not introduce character instructions without compromising upwards compatibility. So we defied convention and went for a straight 1900 machine.

It was very successful. Derek Eldridge was chairman of the working party, I was the secretary and Bill Talbot was the Stevenage development representative. Bill was the major force behind this decision.

The 1901 planning was so successful that we decided to explore the feasibility of a still cheaper system, to sell in the £40,000 to £50,000 market. We defined it in a working party which found we could achieve the costs, performance and other key parameters. But the sales costs, assuming a realistic hit rate, ruled it out on profitability, so we dropped the idea. That decision established the 1901 as the entry level to the 1900 range, and we did not revisit that scene till the 2903 was introduced in 1973.

Meanwhile Charlie Portman and his 1904 team (they had a head start as they were using the FP6000 as a basis) improved the 1904 into the 1904/1905 E/F by implementing microprogramming, full 1900 order code and other improvements. We even introduced a segmentation and paging form of addressing as an alternative, supported by the George 4 operating

system. I remember Frank Sumner coming from Manchester University to help us specify suitable parameters. The 1904/1905 E/F gave us a 1900 architecture and a template design that was used over and over again without further architectural changes.

Incidentally, the "E" stood for Enhanced. I have forgotten what "F" stood for — probably it was just the letter that came after "E".

We had a problem at the high end of the range, where we could not make machines powerful enough to compete with the most powerful IBM 360s. To alleviate this shortfall, we took two 1904/1905 E/F processors and tightly coupled them to make a "dual" system, with nearly twice the power of the basic processor. The operating system scheduled the work between the two processors, and the user saw them as a single resource. This "anonymous multiprocessor" design gave us valuable experience for future systems.

By this stage we were into 1966. That was the time when we in this country were beginning to talk about a British supercomputer, with the "three wise men" advising the Government and Project 51 *et al* being debated. We in ICT eventually responded by proposing 1908, based on the experience of the dual processor 1906/1907 E/F and our good segmentation and paging scheme. The 1908 was to be a tightly coupled multiprocessor tying four powerful processors together with a shared large common store. This proposal was overtaken by events.

At the end of this first phase of development we had accomplished a well understood architecture and some stable designs. We had also identified some major weaknesses in the architecture that we were unable to correct. So we knew in 1966 that, in the long term, we would need to introduce a new range to replace the 1900.

But we were on a treadmill. We could do nothing major. We had the ability to develop four 1900 systems in parallel, but the life of a series in the market was roughly the same as the time it took us to develop its replacement, so we had to keep running to stay in the same place.

The rapid advance of technology helped us. We understood the technology trends and, when we started the usual working party to define and plan the 1900A series, we decided to define it in such a way that it could be enhanced into its successor (the B series) without a major redesign. Instead we would rely on the relatively simple replacement of modules when faster technology became available (such as faster stores and faster clock speeds achieved using faster but compatible logic components).

That strategy worked well. The A/B series was the last major wave of development on the 1900, and we were able to withdraw development resources from the 1900 teams as early as 1969, while keeping the range competitive with the introduction of the B series. That was announced in 1971 as the S series (B was not a good name in the market — S stood for Sprint, which created a much better image).

The architectural weaknesses I have mentioned were only weaknesses from a long term perspective. In the medium term the 1900 had plenty of life left in it, especially in the lower part of the market. But in 1968 the merger of ICT with English Electric (with its System 4 range) added a new urgency to the introduction of a (drastically changed) New Range to unify the new company. But that is another story...

Editor's note: this article is based on the talk given by the author to the Society at the Science Museum on 30 May 1996, as part of the ICT/ICL 1900 seminar. Dr Pasquali was responsible in ICT for the technical planning of the 1900 range from 1964 to 1968, when he left Product Planning to participate in the design of the ICL New Range.

Obituary: John Pinkerton

David Caminer

Dr John Pinkerton, Chief Engineer of the world's first routinely working electronic business computer, Leo, died suddenly at his home in Esher on 22 December 1997, aged 78.

John joined J Lyons & Co in January 1949 following the decision of the company, then Britain's best known caterer, to build a computer of its own to cope with its mass of paperwork. There was no alternative supplier. Indeed, there was no electronic stored program computer in operation anywhere at that time.

John was recruited from Cambridge University where he was undertaking research after graduating there in Natural Sciences and spending the war years on vital radar work at the Telecommunications Research Establishment, Swanage and then at Malvern.

John's first task at Lyons was to create an engineered version of the Edsac scientific computer that was then being completed at Cambridge. He accomplished this with a small team to such effect that the world's first regular, routine, time-critical business application started running on Leo I in November 1951.

Further development provided Leo I by the end of 1953 with the facilities required for full scale integrated office work, including multiple inputs and outputs, concurrent computing and I/O, and automatic conversion. In February 1954 the Cadby Hall Bakeries payroll, the first such application anywhere in the world, began weekly operations.

John Pinkerton, still with a team that was tiny by today's standards, went on to design Leo II, embodying the experience gained in intensive live running. In 1959 he was appointed a director of Leo Computers Ltd, the company formed by Lyons to market the system. Leo II was sold to several major companies, including the Ford Motor Company.

At Leo Computers John designed first the Leo III and then the Leo 326. His Leo III design incorporated both timesharing and multiprogramming capabilities as well as being faster and smaller than the earlier models, and was delivered to customers two years before IBM had even announced the 360 series. The 326 won from the Post Office the largest order ever placed with any European computer company up to that time, in competition with every other vendor on the market.

Book Reviews

Computer: A History of the Information Machine by Martin Campbell-Kelly and William Aspray, Basic Books, 1996.

'Antiquity' in electronic computing is relatively recent. The earliest electronic computing machines dating from the 1940s and early 1950s are still within living memory. Serious historians have been properly cautious in avoiding premature commitment as we struggle to absorb the explosive phenomenon of the computer into our assumptive worlds.

General historiography of modern computing has been commandeered by journalists, who regale us with tales of Californian misfits who catapulted themselves from garages to multinationals in less than a decade. The sensational rise of Apple and Microsoft, of Wozniak, Jobs and Gates has become a parable of modern entrepreneurial success.

The prehistory of modern computing highlights visionary individuals, Charles Babbage and Herman Hollerith in the 19th century; Alan Turing, Presper Eckert, John Mauchly, John von Neumann and many others in this century. The genre is that of heroic narrative with a focus that borders on fixation with invention and hardware. Memoirs of pioneers and 'gee whizz' accounts of the computer's 'remarkable story' have been the non-specialist staple.

Computer marks an important transition from this frenzied scramble to a more reflective history. A clue to the treatment is in the subtitle. The machine is not treated as a jumped-up number-cruncher capable of phenomenal feats of arithmetical wizardry in a stunningly short time. Nor is it treated as an 'electronic brain' with pretensions to intelligence vying with its human makers for intellectual supremacy. In fact 'artificial intelligence' (AI) does not feature at all.

We have instead a history of the computer as Information Machine. What distinguishes *Computer* is its shift from heroes and wondrous machines to the cultural and economic context that predisposed one or another venture to succeed. We are not asked to marvel but to reflect.

Computer is written by two leading historians of computing, one English and one American. Both belong to the transitional generation. Neither is a first generation computer pioneer. Nor are they kids for whom general-purpose computers with sophisticated graphics interfaces are commonplace objects rather than mystifying devices that threaten or perplex.

Without wishing to do violence to notable exceptions, American historians of technology traditionally favour contextual history, the Brits, a more internalist cut which tends to focus on the workings and development of devices and systems. Campbell-Kelly, reader in computer science at Warwick University, is himself an exception to this generalisation having straddled the two traditions with his *ICL: A Business and Technical History* published in 1989.

Despite the transatlantic balance in the nationality of the authors the book is weighted in favour of the US. The first automatic electronic calculator, the Eniac developed for military use at the Moore School, Pennsylvania during the second World War, Project Whirlwind, the Sage air defence project, the Sabre airline reservation system and others feature prominently as do the origins and rise of IBM and other US corporations involved in the scramble for computer markets.

British projects of local legend, the Colossus at Bletchley Park used for wartime code-breaking, and the Manchester SSEM which ran the first stored program in June 1948, receive short shrift. Even Britain's Lyons Electronic Office (Leo) developed specifically for commercial use gains nary a mention. This may be a conscious tailoring of content for the US market (all prices are in US dollars). Alternatively it may be that in the 'new history' which seeks to account for the dominance by the US of technology and markets, Britain, despite its early inventive lead, became an economic bit-player in the world picture.

The first half of the book recounts the history and prehistory of computing and office data processing starting in the 19th century when 'computer' denoted a person, and ending with the rise of IBM and its fall from grace in the mid-1970s. The account avoids the well-rehearsed chestnut disputes of US versus British technological precedence, the bitter personal vendettas, the undignified scramble for historical credit in the US amongst some of the pioneers of the Eniac, and the merits or otherwise of the patent lawsuit that ensued. These episodes are recounted with wholesome neutrality and the welcome voice of historical distance.

The second half of the book is groundbreaking. It attempts to frame the developments of the last two decades including the personal computer 'revolution' and the advent of the Internet and the World Wide Web. More significantly, it attempts, uniquely in a modern non-specialist account, a history of software and the role and development of programming languages. The watchword throughout is not sensationalism but considered sobriety. This is an historically brave and highly accomplished work which

achieves in deed what every book proposal routinely promises, authority and accessibility. *Doron Swade*

Turing's legacy: A history of computing at the National Physical Laboratory 1945-1995 by David M Yates, published by the Science Museum 1997, ISBN 0 901805 94 7.

This is an important book. Organised chronologically, it gives a detailed account of all the various work at NPL in the field of computing and in associated disciplines over the most astonishing decades of this century. Perhaps the most immediately interesting sections for members of the Computer Conservation Society are those most clearly associated with the genius of Turing — the successive developments of Pilot Ace, of Deuce and of Ace. What giant undertakings these were, and with what assurance they were undertaken!

Then there is the account of the whole rise of the intermarriage between computing and communications, and the vital part NPL took in this. The development of the world's first local area network is noticed almost in passing, with none of the trumpets that an American account would have included.

Along the way one finds sections devoted to all the major topics of interest over the past 50 years of computing — languages, machine translation, mathematical computing, pattern recognition, human-computer interaction, security and many others. Due credit is given to the NPL's noble work in the formulation and propagation of standards.

Each subsection closes with a punctilious list of the people involved in the work and a tabulation of the reports and papers which were produced. These features alone will make this an indispensable work of reference for future historians.

An underlying theme is the management of research. First, Yates is illuminating on how the character and interests of successive superintendents defined the atmosphere during their terms of office. Secondly there is the whole question of the change in Government attitude, from the hands-off approach of the fruitful forties and fifties to the increasing imposition of dogmatic considerations of commercial and competitive advantage, with the concomitant rundown in pure research. The quiet tone makes the sorry account of this all the more effective, until the author can wryly comment that concern about golden eggs appeared to outweigh any interest in the welfare of the goose. An appendix gives brief biographies of many of the

people mentioned in the text, and another lists more than 100 patents related to computing at NPL.

Altogether this is a fine book recording a fine and honourable tradition of excellent work. *Hamish Carmichael*

Leo: The Incredible Story of the World's First Business Computer, by David Caminer *et al*, published by McGraw Hill, ISBN 0-07-009501-0.

This is the American edition of *User-Driven Innovation*, which was reviewed in *Resurrection* issue 16. It has a new and punchier title, and has been revised, in David Caminer's words, with a view to "making the text more reader-friendly to the American man and woman in the airport terminal". In addition, a number of passages have been expanded to give additional American references. On top of that, the price is significantly lower — $22.95 in the US, or £18.99 in the UK. *Nicholas Enticknap*

Csirac booklet

Australia's first computer was briefly mentioned in *Resurrection* issue 18. Although the exact date of the running of its first program does not seem to have been exactly recorded, it was some time in 1949, and it is remarkable that such an early machine should have been so little known hitherto.

Now the Australian Computer Museum Society has published an excellent booklet about it. In just under 50 pages it covers the historic and technical background, and sets the Australian Mark 1 in the context of other pioneering work in the UK and the United States.

There is a summary of the applications on which it was used between 1949 and 1965 — by any standards a long and honourable life. The technical specification and physical layout are shown. The function code is listed, and there is an explanation of the method of programming. Versions of the "Primary" and "Bootstrap" routines are shown in full. There is a bibliography, a list of relevant Web references, and an index.

Copies may be obtained from the author, John Deane, c/o the Australian Computer Museum Society, PO Box 103, Killara, NSW 2071. The cost, including postage, is £6.00. Sterling cheques are accepted, and should be made out to The Australian Computer Museum Society. Highly commended. *Hamish Carmichael*

Small-Scale Experimental Machine

Chris Burton

Work to improve the reliability of the three cathode ray tube stores has progressed only slowly, as various subsidiary tidying-up activities hampered a systematic effort. Nevertheless, the number of occasions when a program would run for half an hour or more increased as we approached the new year. Lower-level problems have consequently become more apparent, such as the need to apply interference suppression to the control switches. The reliability of the main computer logic seems to be quite good, apparently better than was the case in 1948. This is ascribed to the suggestion that the valves we are using were made in the 1960s, when higher quality manufacturing techniques were in place.

Over the past few months, Manchester Computing installed a camera to send out over the Internet continuous live video pictures of the SSEM and any activity around it. We also received an increased amount of media attention, partly focussed on the competition which we launched in November to see who could write the "best" program to run on the machine. Details of this can be seen at the Web site www.computer50.org.

The machine was dismantled and moved to the Museum of Science and Industry in Manchester at the end of February, in accordance with the schedule we drew up in 1995. The move went extremely smoothly, and the machine was reassembled and was running a program two days later. The project is now sited on the top floor of the 1830 Warehouse, the world's first railway goods warehouse, in very appropriate surroundings. It closes a very happy two years working at the University of Manchester. We now must consolidate the machine physically, and improve the reliability ready for all the celebrations taking place in June.

Bombe Rebuild Project

John Harper

Those who have had the opportunity to visit Bletchley Park since last September will already know that we have completed the frame. This is on display together with a range of wall panels which explain some of the history surrounding the building of the Bombes at Letchworth by the

British Tabulator Machine Company (BTM). As most readers will know, BTM was originally tied in with IBM but later became part of ICT, and then ICL. Incidentally the project name used for the Bombes in Letchworth was Cantab. As most people making the Bombes were only told what they needed to know, they would not have heard the word Bombe used until after the war and maybe not even then.

There was a range of Bombe types produced over a period of five years. The one that we are building is a three wheel, 36 Enigma version with Siemens type high speed sense relays. The rebuild will be similar to those that were being delivered at the very end of 1943.

Progress since September has been consistent and steady but not very visible. Due to the state of the original drawings it has been found necessary to copy them. We are using a Computer Aided Design package which brings with it many advantages. The redrawing is about one third complete for the drawings that directly relate to the Rebuild, but there are many more which need preserving. We are looking for more help with this redrawing operation and with other specific tasks: for more details please see the Appeal for Help on the next page.

The most recent activities have been to identify down to the "last nut and bolt" every item required to complete the mechanical side of the rebuild. This has been necessary because very few assembly drawings have been preserved although information on individual parts is good. The mechanical side is now virtually complete and we have now started in earnest in recreating the wiring diagrams, schedules and looms from fragments of incomplete information.

Simulators

Simulators for a variety of historic computers, including Edsac, Elliott 903, Pegasus, the Manchester University Small-Scale Experimental Machine and Zebra, can be found at our FTP site. Access details are on page 43.

Bombe Rebuild Project — Appeal for Help

The Bombe Rebuild Project is appealing for help from anyone with skills in the following areas:

AutoCad draftsmen preferably with their own IBM-compatible PC (AutoCad software will be supplied). Needed to copy all the drawings required for the rebuild; and also to copy the rest of the drawings before they are lost forever through fading.

Project Facilitators/Estimators to take copies of mechanical drawings out to potential manufacturers, obtain quotations, and ultimately progress the manufactured parts through to delivery.

Fund raiser to seek out prospective sponsors and coordinate presentations and submissions. The amount needed runs well into six figures, so there will be a need to deal with relatively large organisations.

Small specialist part manufacturers with access to a modern, precision, well equipped workshop. One person is currently manufacturing special drilling jigs and parts for the Bombe Jack Frame: as more drawings become available more people will be needed.

Small simple part manufacturers with a small domestic workshop with cutting and drilling facilities. There are many small simple steel and insulating material parts which need to be made.

The Project is also looking for many Hollerith/BTM parts: a list is available for anyone who thinks they can help.

Anyone who thinks they can assist in any way with this exciting historical project should contact Project Manager John Harper on 01462 451970, or by e-mail at bombe@jharper.demon.co.uk.

Peter Hunt

Just as we went to press we heard the sad news that Peter Hunt had died. Peter was, in the words of his colleague Derek Milledge, "a giant amongst the pioneers of software management in the British computer industry". Many members will recall his talk at our ICT/ICL 1900 seminar in 1996. We plan to include a fuller appreciation in the next issue.

Letters to the Editor

Dear Editor,

Recent recollections of Professor Hartree in *Resurrection* remind me of the "constant" which took his name in the days when the first commercially produced computers were being delivered. He pronounced that the time quoted by the supplier for delivery was a constant.

This was remarkably true in the late fifties and early sixties. If one was quoted six months at the time the order was placed, that was still what was promised six months later — that is if the machine was even going to be produced at all!

Yours sincerely,

Cecil Marks
Banstead
Surrey
15 November 1997

Dear Sir,

I have some comments to add to Bob Beard's excellent article *The KDF9 Computer — 30 Years On.*

My contact with the KDF9 was as Head of the Computer Science Department within the University of Sydney School of Physics. The School was then headed by Professor Harry Messel, a cosmic ray physicist who has just retired as Chancellor of Bond University, Australia's first and largest private university.

Messel had persuaded Dr and Mrs Cecil Green of Dallas, Texas (Cecil was one of the founders of Texas Instruments and of Geophysical Instruments Inc) to donate $US50,000 towards a successor to the School's computer, Silliac, which had been commissioned in 1956.

In the event, with considerable help from English Electric and the Nuclear Research Foundation, a private foundation associated with the school, a KDF9 was purchased and became operative in April 1964.

As Beard's article suggests, the KDF9 had a stack designed to overcome the mismatch between the storage access time and the compute time. Store accesses were minimised by the stack, which permitted the use of addressless instructions. The language used was based on the re-

verse Polish notation which had come to the notice of the English Electric engineers because it was embodied in George, a programming system developed for Utecom, the English Electric Deuce computer which had been installed at the University of Technology (later renamed the University of New South Wales) — not the University of Sydney, as stated in Beard's paper.

George was the work of Charles Hamblin who, until his death in 1985, held the Chair of Philosophy at the University of Technology/NSW. Charles and I had been members of the same RAAF radiophysics training course conducted by the School of Physics in 1942 for potential radar (then called radiolocation) officers.

In the mid sixties I arranged for the KDF9, Silliac and a small process control machine, the CDC 1700, to be interconnected as a local area network — one of the world's first Lans. The system was engineered by Chris Wallace (recently retired from a Chair of Computer Science at Monash University) and the software was the work of John Winings. It provided for online access from a dozen keyboards. Later a PDP-8/338, which was used as a graphics teaching tool, was added.

Yours sincerely,

John M Bennett
NSW
Australia
25 January 1998

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 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**. The pages of information at our Web site include 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 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.computer50.org/
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

18-19 April 1998, 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

17-19 June 1998 Golden Anniversary Conference, University of Manchester

A celebration of the birth of the first stored program computer

29 September 1998 North West Group meeting

"The Early Days of the NCC" by Ron McQuaker

The North West Group September meeting will take place in the Conference room at the Manchester Museum of Science and Industry, starting at the 1730 hours.

Arrangements for London meetings in April and May were in hand as we went to press, but had not been completed: for information readers should refer to the insert enclosed with this issue.

Queries about London meetings should be addressed to George Davis on 0181 681 7784, and about Manchester meetings to William Gunn on 01663 764997. Queries about the Golden Anniversary Conference should be addressed to The 1998 Conference Office, Department of Computer Science, The University, Manchester M13 9PL. Tel: 0161 275 6269.

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