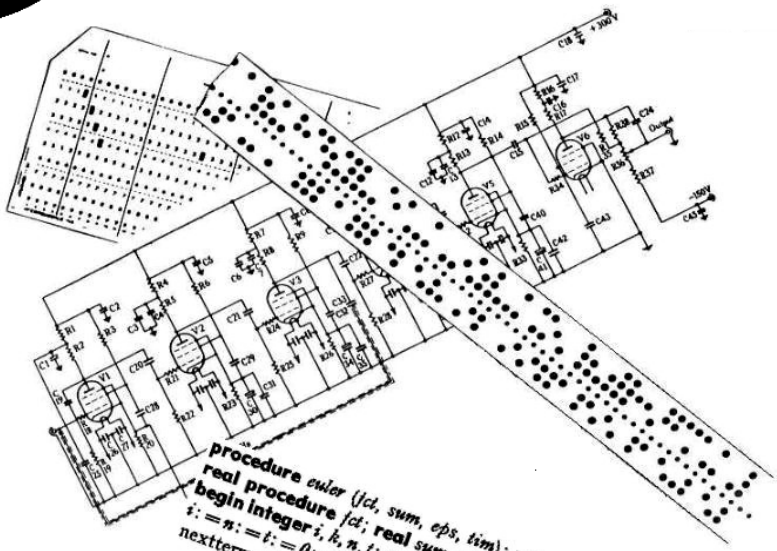
Issue Number 71 Autumn 2015

RESURRECTION

The Journal of the Computer Conservation Society



```
procedure euler (fct, sum, eps, tim); value eps, tim; integer tim;
real procedure fct; real sum, eps;
begin integer i, k, n, t; array m[0:15]; real mn, mp, ds;
    i:=n:=t:=0; m[0]:=fct(0); sum:=m[0]/2;
nextterm: i:=i+1; mn:=fct(i);
    for k:=0 step 1 until n do
        begin mp:=(mn+m[k])/2; m[k]:=mn; mn:=mp end means;
    if (abs(mn)<abs(m[n]))∧(n<15) then
        begin ds:=mn/2; n:=n+1; m[n]:=mn end accept
    else ds:=mn;
    sum:=sum+ds;
    if abs(ds)<eps then t:=t+1 else t:=0;
    if t<tim then go to nexterm
end euler
```

Computer Conservation Society

Aims and objectives

The Computer Conservation Society (CCS) is a co-operative venture between BCS, The Chartered Institute for IT; the Science Museum of London; and the Museum of Science and Industry (MSI) in Manchester.

The CCS was constituted in September 1989 as a Specialist Group of the British Computer Society. It is thus covered by the Royal Charter and charitable status of 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,
- ◊ To develop awareness of the importance of historic computers,
- ◊ To develop expertise in the conservation and restoration of historic computers,
- ◊ To represent the interests of Computer Conservation Society members with other bodies,
- ◊ To promote the study of historic computers, their use and the history of the computer industry,
- ◊ To publish information of relevance to these objectives for the information of Computer Conservation Society members and the wider public.

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

The CCS is funded and supported by voluntary subscriptions from members, a grant from BCS, fees from corporate membership, donations and by the free use of the facilities of our founding museums. Some charges may be made for publications and attendance at seminars and conferences.

There are a number of active projects 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 CCS also enjoys a close relationship with the National Museum of Computing.

Resurrection

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Chair's Report for 2014-5

Rachel Burnett

We have been steadily active this year with the progress of our projects, our programme of presentations and other events, our publications and other activities. Our membership continues to increase, currently at over 1,400 members.

Projects

We have 13 ongoing projects, mainly for restoration and reconstruction. They are listed at the back of *Resurrection*, where the continuing achievements made by CCS expert volunteers are regularly reported.

Sadly, work on the Hartree Differential Analyser project and the Pegasus Peripherals project has had to cease, because the Manchester Museum of Science and Industry has closed the Computing Gallery as part of its planning for future galleries. Thanks to Charles Lindsey, Brian Russell, Dave Wade and other team members for their consistent work over many years utilising their considerable and unique experience.

Events

We have had interesting presentations by experts on a variety of topics of relevance to our members from speakers experienced in their subject, who can bring it to life, whether on machines, software, systems or an aspect of their social, corporate or historic context.

As part of our 25th anniversary celebrations a year ago, Doron Swade MBE, co-founder of our Society, an eminent historian of computing and formerly Assistant Director & Head of Collections at the Science Museum, gave a deliberately thought-provoking presentation entitled Computer Conservation and Museums: Fight or Flight? This was an opportunity for us to review the value of restoration and reconstructions of early computers in relation to history, to society and to museums. We are completely convinced of the social and historical value of these

activities. We must keep promulgating this philosophy and practice, to ensure that we provide convincing arguments to those who, unfortunately, do not share our view.

Outside our regular programme of presentations, we enjoyed a guided tour of the wonderful Heinz-Nixdorf Museum in Paderborn (we are arranging another museum tour abroad next year), and a second visit to IBM's Development Centre at Hursley and a tour of its museum.

Thanks to our speakers; to Roger Johnson and Gordon Adshead for organising the programmes in London and Manchester respectively; to our audiences for attending and for participating in the lively discussions following the presentations, or who visited Hursley or Paderborn with us; and to our hosts at Paderborn and Hursley.

Publications and Website

Resurrection, edited by Dik Leatherdale, records CCS activities, events and project progress. It publishes news, articles and other features in relation to historic computers and software. The magazine is funded by *BCS the Chartered Institute for IT*. This year, with costs of production and circulation constantly increasing, distribution arrangements have changed. Print copies will be sent to all CCS members who are also BCS members or former members of more than 60 years of age and of five years standing. Others may choose to receive the printed version by paying £10 a year. The magazine remains available online to all. Both current and past issues can be downloaded.

Our CCS website, *www.computerconservationsociety.org*, also Dik's responsibility, gives information about the Society, news and our programme of events. We have an FTP site at *www.cs.man.ac.uk/CCS/Archive/*, with other materials for downloading. Simon Lavington is the Digital Archivist of the Our Computer Heritage website, which provides technical information on the majority of British-designed old computers. It now supports original mainframe systems, a new minicomputer section, and information sets collected by volunteers. These websites have been integrated in similar CCS style by Rod Brown.

Thank you Dik, Simon and Rod, and all who have worked on these sites, for all your terrific work on *Resurrection* and the websites.

The Tony Sale Award

The purpose of the CCS Tony Sale Award is to recognise outstanding achievements in computer conservation. It was made last autumn to two outstanding and equally deserving winners. The winners *were Z1 Architecture and Algorithms*, a virtual reconstruction of the 1930s Konrad Zuse mechanical

computer, by the Free University of Berlin, and the *IBM 1401 Demo Lab*, a restoration of one of the most significant machines in computer history by the Computer History Museum in California.

Thank you to the judging panel, the organising committee and to our TSA co-ordinator, Peta Walmisley.

Museums

Over the last twelve months the museums with which we are associated have had successful activities and exhibitions relevant to the CCS. The Science Museum has opened a new gallery, Information Age, based round "Six Networks Which Changed The World", representing 200 years of information and communications technologies. Work has started on a new Mathematics Gallery, scheduled to open in late 2016. A dedicated team of volunteers at the Museum of Science and Industry in Manchester continues to run successful and popular interpretations and demonstrations of the replica Small-scale Experimental Machine. At Bletchley Park Trust, Hut 11A, which housed Bombe machines during WW2, has been fully restored. The National Museum of Computing has opened a new gallery including the West Drayton ATC system. It is attracting more and more visitors.

This year we are very pleased to have developed an informal association with the extensive Jim Austin Computer Collection of over 1,500 computers in Yorkshire.

Committee

I must thank our Committee members who put in so much work for the CCS, including Museum representatives and Project Leaders, and Tom Hinchliffe, Chairman of the North West group. In particular, I thank Roger Johnson, Secretary; Kevin Murrell, Meetings Secretary; David Hartley, Treasurer and Projects Co-ordinator; Dave Goodwin, Membership Secretary; Dan Hayton, Media Officer; and Martin Campbell-Kelly, Archives Adviser. Thank you to all and to all other volunteer workers. We welcome assistance on organising and administration; do please contact myself or any Officer if you would be willing and able to help!

Many thanks to all of you who support the CCS and for your generous support for our General Donations Fund which enables the CCS to provide the ongoing support needed for our computer restoration projects.

Society Activity

EDSAC Replica — *Andrew Herbert*

The increment in chassis count since the last report is, of 142 total to be built:

–Designed	126->129
–Metal cut	126->128
–Built	97->102
–Standalone test	61-> 61

Good progress continues to be made but, as might be expected, commissioning is showing up a number of system integration issues that need to be addressed.

There have been concerns over the stability of the clock pulse generator and the ability of the clock/digit pulse system to deliver large and sharp enough pulses for all the sub-systems that depend on them. Peter Lawrence and John Sanderson have made various adjustments and improvements and report the unit is now working satisfactorily and reliably.

Chassis 01 (storage regeneration unit), of which we have 42 in the system, also remains a concern. Measurements by Les Ferguy and others have shown sensitivity to valve condition and input signal levels. This remains under investigation and is on the critical path to finalising the design of the interface to the nickel delay line store.

James Barr reports that the order decoding system is complete and good progress is being made on commissioning main control, including the all-important START button.

Nigel Bennée continues with constructing and commissioning of the arithmetic system, anticipating delivery to TNMoC by the end of the year.

Chris Burton completed the design of the display units and is now undertaking construction.

John Sanderson continues to work on the initial instructions loading unit and engineer's switches.

The failing power supply unit reported last time has been returned by the manufacturer with "no fault found" and would indeed appear to be functioning correctly once more.

Martin Evans has started to investigate circuits for the I/O system (tape reader, teleprinter) based on Bill Purvis' logical design.

Peter Linington has made progress with understanding the sources of echoes, distortion and attenuation in the prototype nickel delay lines. Building on this he now has a revised prototype under test that shows much less susceptibility to errors. His next task is to finalise the interface to chassis 01.

In terms of completion of the project it is looking less likely that we will be able to demonstrate EDSAC "computing" by the end of the year than had been previously hoped, but doing so by the late spring of 2016 remains a strong possibility.

IBM Group — *Peter Short*

Much has happened to our AS/400s in the last few months. After fixing a disc subsystem problem on one of our AS/400es we now have four working machines — An AS/400e Model S20, two AS/400e Model 170s dating from the 1990s, and an iSeries Model 270 dating from the 2000s. We have successfully attached an IBM 3570 Magstar tape library to the Model S20 and an IBM 3590 tape drive to one of the Model 170s.

On the software front, we are now running OS/400 5.2 on the two 170s and OS/400 5.4 on the 270. We have installed IBM MQSeries on one of the Model 170s and have it running successfully. We are also getting close to having CICS/400 running on the Model 270.

The AS/400s are part of our on-going drive to try to show more IBM software, especially that derived from Hursley such as CICS and MQ.

Ferranti Pegasus — *Rod Brown*

Both Len Hewitt and I attended the Science Museum on the evening of 14th July once the public had left the building. And against a considerable set of obstacles, including working without normal lighting in the gallery, we managed to capture photographs of the outstanding repairs remaining on the machine. This is needed to create the conservation document which the CCS has confirmed it will produce. Currently this action is with Len who has a comprehensive overview of the history of this project.

Ferranti Argus (Bloodhound) — *Peter Harry*

My last and rather protracted report related the conversion of our Argus 700 system from its rather obscure FINCH disc interface to SCSI-2. That task is now complete, after overcoming a few challenges which included; you do not use the 'Format and Copy' utility to format a larger capacity (>1Gb ish) SCSI-2 disc, you use the 'Disc Test' utility — obviously! Such are the trials of working with computers on which you start with no knowledge or experience. That said, we have had a tremendous amount of support from individuals, ex Ferranti, who do know what they are doing.

With the objective of keeping the Argus 700 running in perpetuity we have now completed the final stage of our SCSI conversion — the Seagate ST31200N SCSI-2 disc has been replaced by a solid state disc emulator. We are now running the Bloodhound simulator with its Argus 700 on a CF card. Such a dramatic change in the disc technology from the original CDC Wren 1 (FINCH) has resulted in a system boot time of 23 seconds as opposed to the original 4 minutes! The conversion to solid state was not a simple 'plug and play'; it involved a good deal of support from the supplier to get it to work with the peculiarities of the Ferranti Argus.

We do have one remaining item which is mechanical and rotates, the Archive 2150L tape drive. Unless someone else has done the work already we are looking at developing, or not, a SCSI-2 to QIC-02 interface and a solid state tape emulation. SCSI-2 tape emulators exist but we need QIC-02.

The changes made to the disc system for the Argus 700 is to provide security for the future running of the Bloodhound simulator — for many years to come. We retain the original and our last working CDC Wren 1 disc with its FINCH interface cards but will not use them unless there is a need for restoring the Argus to its original configuration for historical or research reasons.

What next, now that the Argus 700 is reliable and running the system it was designed for? The focus of our efforts will turn to maintenance and repairs. We have a batch of faulty Argus cards which require repairing and these will lead us in to designing some sort of test facility and 'something' to drive specific cards. Can we create a test facility where an Arduino or some such device with TTL drives an Argus 700 in a test bench environment? This will be one task for this coming winter.

Software — *David Holdsworth*

Leo III Software Rescue

All of a sudden, it works!

We now have a demonstration showing all our rescued software running, first in a user program mode, but then again genuinely running under the true Leo III master routine. Readers may download it at *leo.settle.dtdns.net/LeoCode/LeoIIIdemo.zip*.

The role of the operator is currently emulated in a somewhat ad hoc way. We have made two very small modifications to the master routine generator to deal with a mismatch of versions, and rather to our amazement, this seems to be all that is necessary. The importance of absolute accuracy was underlined by a misread of a **6** for a **0** which caused mayhem.

In *http://sw.ccs.bcs.org/leo/JohnD/P1000475.JPG*.

Line 67469 should be:

```
67469 6,1,1,1,9;
```

not as typed, viz.

```
67469 0,1,1,1,9;
```

We still lust after a copy of the CLEO compiler. This generated Intercode, and we believe that it was written in Intercode. CLEO was a COBOL-inspired high level language with block structure, or so I am told. I have asked the Leo Society to see if they can find anything.

I am hoping to get some provenance information, and maybe even contents listings. If the list is comprehensive enough, it will be worth trying to read the tapes, now that we have a soft machine that can run them.

Dik Leatherdale and Bill Findlay have assisted in quality assurance of the demo which has now run on Windows (ancient and modern), GNU/Linux, OSX, FreeBSD, Solaris on Pentium, ARM and SPARC architectures. Compilers used were gcc on every system, cc on Solaris, Visual Studio on Windows. The browsable material uses very uncomplicated HTML. This portability should give confidence of future-proofing.

I am still mulling over how best to offer the Leo III stuff over the web. I am pleased with the facility for running a single Intercode program *leo.settle.dtdns.net/LEOIT/N/LeoCode/runleoIT.htm* as an offering which involves no installation on the user's machine, and makes very few demands on the web browser. I am conscious that the CCS mission statement talks of "public display", which for software preservation I take to mean World Wide Web.

Leo III Documentation

As always, our on-line documentation is accessible at:

leo.settle.dtdns.net/LeoMan/Manuals.htm.

There has not been any more progress on a web page intended to give a picture of computing in the 1960s with links to our software for running examples from that era. It is still at the proof-of-concept stage.

Orion Software

Delwyn Holroyd, Alan Thomson and I have exchanged a few e-mails on the subject of Orion OMP software. I am keen to be involved, especially so as the Leo III work is at a stage where I want others to do the leg work. I feel able to advise on transcription of listings and the transition to executable software. There is hope of OCR, but the example above in the Leo III report would counsel caution.

Our Computer Heritage — *Simon Lavington & Rod Brown*

The re-designed OCH website went live on 22nd August. The URL remains the same but the site is now compatible with the look-and-feel of the main CCS site and is much easier to navigate. It delivers a new minicomputer section along with updated content in the original mainframe section.

The new site has been tested and proven on a wide range of devices and seems compatible with a range of desktop and mobile devices. The site provides a wide variety of PDF documents covering the range of CCS-delivered documentation. Any device accessing the site needs to be capable of handling PDF documents.

Analysis of visitor statistics shows that the old site got an average of about 800 to 900 visits a year. About 85% of these are from academic links, as such the current site is a used facility and the work to make it compatible whilst promoting the CCS as an organisation is worthwhile. The site remains a work in progress whilst new content is produced and visitor statistics will continue to be extracted for another year.

North West Group contact details

Chairman Tom Hinchliffe: Tel: 01663 765040.

Email: *tah25@btinternet.com*

Secretary Gordon Adshead Tel: 01625 549770.

Email: *gordon@adshead.com*

ICL 2966 — *Delwyn Holroyd*

In the last report I mentioned the two recently acquired ICL 7181 VDUs. One of these is now on display. The second unit required a lot more work to remove extra wires introduced on the backplane by the previous owner, and to replace missing wires. A set of board extenders was made to allow for component level fault finding. The logic is mainly original series 7400 TTL, with date codes of 1969-1971. Luckily the museum has a large stock of these DILICs (to use the favoured ICL acronym). Several boards have been repaired successfully, so that we now have some spares.

A scan board with failed jiggle scan output transistors is proving more difficult to repair – the type of the originals is unknown as they are marked only with house codes, and the circuit is evidently very sensitive to the behaviour of the transistors in saturation. The second 7181 will go on display when all the spare board faults have been addressed.

As mentioned in the summer report none of our units have the rack up feature which is required by George MOP to scroll the screen. To get around this problem we are now running Maximop as a job under George, and making use of its 'direct graphics' feature. This means that subject programs are able to write cursor control codes directly to the terminal thus avoiding the need for scrolling output.

Two programs making use of direct graphics have been developed in Algol 60, both based in part on earlier work from Manchester Grammar School: #OXOD, a noughts and crosses program that uses a learning algorithm to play (badly); and #LIFE, an implementation of John Conway's famous cellular automaton.

Work has continued on the GTS2 tape decks. We are now able to read data from one of the decks using the New Range Peripheral Interface tester, although some unreliability still needs to be investigated. The second deck in the cluster is now able to load tapes and will read the first block, but the second always fails. This is likely to be a problem with positioning.

The machine is now generally operational every Thursday and Saturday. We have experienced unprecedented reliability over the summer with hardly a crash to report. The expanded terminal area is very popular with visitors, particularly children who enjoy beating the noughts and crosses program!

Harwell Dekatron — *Delwyn Holroyd et al.*

The machine has run quite reliably over the summer months. A couple of store diodes have been replaced along with some anode resistors. One of the trigger tubes in the pulse generator became erratic and was replaced. A dirty switch contact caused the manual input control panel to become inoperative.

I am sad to report that Bart Fossey, one of the original users of the HDC at Harwell, has died aged 87. Bart was present at the reboot of the machine in November 2012, when he re-enacted the famous 'race' between the Facit calculator and the machine. You can read memories of Bart on the TNMoC website: *www.tnmoc.org/news/notes-museum/bart-fossey-1927-2015*.

TNMoC has learnt of the existence of a painting of the machine, created by artist John Yeadon in 1983 when the machine was on display at the Birmingham Museum of Science and Industry. By that time the machine was no longer operational, and clearly made a big impression on John:

"It was a diabolical contraption, a dusty hunk of electric and mechanical hardware that reminded me of the disturbing 1950s Quatermass science fiction television series that so impressed me as a child. But the computer was abandoned in a museum like an ancient relic. Vintage twentieth century technology doesn't seem to fare as well as nineteenth century working steam engines with their polished brass pistons. I wanted to give this dead computer new life, but with menace and humour, so I approached the painting in in a playful, lively, anthropomorphic way and included an abacus and Babbage's brain in a glass dome on a table in front of the computer."

The current whereabouts of the painting are unknown, and John would like to locate it for a retrospective exhibition in two years' time. At seven feet high by nine feet wide the painting is almost life size, and would be hard to miss! Please contact TNMoC if you know where it is.

Many readers will be familiar with the story of the Wolverhampton schoolboy who, between school and university wrote a program for Messrs. Chubb, .which received some publicity in the local paper. Not long ago, we discovered that there was a second participant in this effort: Mike Tedd went on to become Professor of Computer Science at Aberystwyth University. He visited WITCH during the summer and entertained the operators with his tales of days gone by. Your editor has twisted his arm to put it in writing.

Analytical Engine — *Doron Swade*

There has been a new archival find in manuscript papers Babbage gave to a younger colleague, Harry Wilmot Buxton. The Buxton papers are held by the Museum of the History of Science, Oxford. The papers were known about and some material has been published but last time the papers were viewed predates the focussed interest on the Analytical Engine, and the significance of the material on the Mechanical Notation passed unnoticed. With the kind permission of the archivist, permission was given for a copying rostrum to be used and the relevant material was digitally photographed in situ. The significance of the material is twofold: it contains Babbage's efforts to provide generalised rules for annotating his mechanical drawings; secondly, the principles it documents confirm our findings from the earlier exercise in which knowledge of the Difference Engine mechanisms were used to decode the Notations that describe them — this without the benefit of an generalised rules of syntax or grammar. The agreement between the archive and our earlier findings is a satisfying vindication of the decoding method using known mechanisms.

The Ada Lovelace bicentennial, celebrated this year, has directed attention to the Analytical Engine through the description of the Engine which Lovelace published in 1843. Her description of the Engine is in the form of Notes which form a substantial addendum to the account by Luigi Menabrea who wrote up some of Babbage's lectures on the Analytical Engine Babbage gave in Turin in 1840. The ongoing preparation of celebratory exhibitions, symposia and media coverage, has redirected attention to specific features of Lovelace's description. One such is the use control arrangements between the punched card input and the routing of information between the cards, processor and memory. There is evidently no form of indexed or relative addressing either of which would be required for the AE to execute the example given by Lovelace — the automatic calculation of Bernoulli numbers. It is far from clear how the Engine executes its control functions and there are several ongoing collaborative conversations between scholars and historians analysing the issue stimulated by the extended interest in Lovelace's work. The lesson we have taken is that much as is known about the principles of the AE, there is much that is not understood at the fundamental level of internal control and such understanding is a prerequisite of any construction, physical or virtual.

Elliott 803/903 — *Terry Froggatt*

One day in spring, the 803 was too cold to switch on due to problems with the 21 year old, very expensive (ex Nimrod) 26v battery. In summer, sometimes the building has been too hot for the 803 to be switched on. The 903 is less temperature sensitive, and it usually on whenever TNMoC is open.

As promised in my previous report, I've checked the 903's paper tape readers. The normal reader appeared to be OK, and I suspect that the reported problems were more due to errors in the (rather worn) demonstration tapes. If there is a problem with this reader, it is that the rear right guide pin was broken off a couple of years ago, allowing tapes to wander. If anyone can get the bottom of the old pin out, I can supply a replacement pin. The light beam of the spare tape reader was off to one side of the photocells. When I took the cover off to adjust the lamp, I spotted that the pillar that holds the filament was between the filament and the lens, so I turned the lamp though 180° and realigned it onto the photocells. It has been in regular use since.

A fault developed on the carriage return mechanism of the teletype which has been fixed.

A rectifier which failed in the power supply for the 903's extra store module was replaced last year, but since then the 8192-word extra store has not worked correctly. TNMoC's usual educational demonstrations only need the first 8192-word store, so this is not a major problem. By swapping boards with my own machine, I've located and swapped out a faulty A-ED3 board, which has revealed that there is another fault, seemingly not on the boards. The frequency of this varies slightly whenever I run my test programs although the symptoms are the same. I've checked some of the connectors, but others are inaccessible, now that the 903 is between a wall and a busy corridor.

The paper tape punch on the 903 refuses to punch the least-significant track. We cannot just swap in another punch: the connectors on this punch and corresponding cable are circular, whereas all other Elliott punches have Centronics connectors. I don't think that this is a lubrication problem: the track does punch when you hold the solenoid down by hand, and I've established that it is not a fault in the paper-tape station electronics. So this is probably a cable or connector fault.

On the software front, following on from my visit to the National Museums of Scotland in April last year, I've been allowed to borrow six of their paper tapes which I thought worthy of inspection. (I had to sign NMS's standard agreement that I would not dissect them, or chemically treat them). Amongst them was a program to play the "Sailors' Hornpipe", to add to our growing 903 music

collection, and a copy the 903 City & Guilds 319 compiler issue 1, with no bytes missing, but otherwise identical to that reported in Resurrection 69.

One of the NMS tapes that I asked to see was "**SIR SYSTEMS VI A**", I'd expected it to be a SIR source file like **SIR SYSTEMS 1**, but it turns out to be a green 903 binary tape occupying about 3000 words. Understanding exactly what it does would be quite a project, but I can tell from a disassembly into pidgin-SIR that it is a multi-level program which uses input 15 384 and output 15 4992, and which includes the following menu strings:

FACILITIES 1: / CLEAR FILE, 0 LEVEL4 PROGRAM, 1, NORMAL MODE

FACILITIES 2: KEYS 0-5 SELECT SCALE OF ROLLUP ROLLDOWN

FACILITIES 3: / SHOW ERRORS, 0 NORMAL (RESET), 1 COMMAND

If you recognise the program name, or the input & output addresses, or these menus, could you let me know at *ccs2@tjf.org.uk*?

London Science Museum

Sad to report that in September the old Computer Gallery was observed being cleared. All the exhibits were roped off, "our" Pegasus was being prepared for transportation into storage at Wroughton and, on the day of our visit, the Hartree Differential Analyser was being dismantled. Will it be reunited with the other half of the DA which has remained at MSI in Manchester all these years? Only time will tell.

In due course a new and spectacular Mathematics Gallery will be erected in the space thus vacated. Something to look forward to then.

News Round-Up

In 2015 the University of Oxford is celebrating the 200th anniversary of the birth of computer visionary Ada Lovelace. The centrepiece of the celebrations is a display at the University of Oxford's Bodleian Library (13th October — 18th December 2015) and a Symposium (9th and 10th December 2015), presenting Lovelace's life and work, and contemporary thinking on computing and artificial intelligence. For more information or to register your interest see *blogs.bodleian.ox.ac.uk/adalovelace/#lovelaceoxford*.

Ada, Countess of Lovelace (1815-1852), is best known for a remarkable article about Charles Babbage's unbuilt computer, the Analytical Engine. This presented the first documented computer program, to calculate the Bernoulli numbers, and explained the ideas underlying Babbage's machine and every one of the billions of computers and computer programs in use today. Going beyond Babbage's ideas of computers as manipulating numbers, Lovelace also wrote about their creative possibilities and limits: her contribution was highlighted in one of Alan Turing's most famous papers *Can a machine think?*. Lovelace had wide scientific and intellectual interests and studied with scientist Mary Somerville, and with Augustus De Morgan, a leading mathematician and pioneer in logic and algebra.

The display, in the Bodleian's new Weston Library, offers a chance to see Lovelace's correspondence with Babbage, De Morgan, Somerville and others, and her childhood exercises and mathematical notes. The Symposium, on 9th and 10th December 2015, is aimed at a broad audience interested in the history and culture of mathematics and computer science, presenting current scholarship on Lovelace's life and work, and linking her ideas to contemporary thinking about computing, artificial intelligence and the brain. Confirmed speakers include Lovelace's direct descendent the Earl of Lytton, Lovelace biographer Betty Toole, computer historian Doron Swade, historian Richard Holmes, computer scientist Moshe Vardi and graphic novelist Sydney Padua. Other activities will include a dinner in Balliol College on 9th December, the eve of Lovelace's 200th birthday.

101010101

Sad to report the passing of John Thompson late of Ferranti. No less a person that Virgilio Pasquali paid this tribute "He was so enthusiastic about the Orion innovative design (to which he had contributed so much) and worked really hard to make it happen. He designed the whole of the Orion CPU while I was responsible for the autonomous peripheral subsystem and Charles Lindsey, our leader, was innovating in other areas while keeping the whole picture together. Yes, initially there were only three of us in the team!"

101010101

It will not have escaped the attention of UK readers that the BBC has suddenly acquired a huge enthusiasm for computers and for all things digital. A season of television and radio programmes considering the world of computers, their consequences and, importantly for us, their history have been aired this autumn.

Readers with an interest in the wartime activities at Bletchley Park will have been fascinated by *Bletchley Park Code Breaking's Forgotten Genius* a biography of Gordon Welchman, a relatively unknown but very important member of the team which did so much to eavesdrop on German communications. You can find it on *YouTube* at *tinyurl.com/gorwel*.

The forthcoming bi-centenary of Ada Lovelace was celebrated in an hour-long documentary by Dr Hannah Fry (UCL) and included contributions by Tilly Blyth and Doron Swade. The Times (no less) said of *Calculating Ada: the Countess of Computing* "A mark of a good biographical documentary is that it makes you long for a biopic on the same subject." It is available on *YouTube* at *tinyurl.com/adalcal*.

And finally Radio 4's *Computing Britain* series was a wide ranging review of UK computer history ranging from the Manchester Baby through Leo and Ernie to the present day. Available at *tinyurl.com/combrit* for 12 months.

For an added touch of authenticity the BBC's *Make it Digital* **SUMMER** roadshow began on the 12th of September.

101010101

We have had an enquiry concerning a structure stress analysis program written for Pegasus by the late Dr John Renton for civil engineers Ove Arup. It is thought to have been used in the design of the Sydney Opera House. If anybody can confirm this or knows anything about it, please contact Chris Burton at *cpb@envex.demon.co.uk.*

101010101

Auctioneers Bonhams have sold for $37,500 the only surviving Cray 4 CPU. Based around an extreme multi-layer module and utilising gallium arsenide semiconductors it bankrupted the Cray Computer Corporation the year before Seymour Cray's untimely death in 1996 and never attracted a buyer. Until now that is.

At the same sale an Apple I failed to sell. Its starting price was a "modest" $300,000.

Donations Request Correction

Rachel Burnett

We are very grateful to those of you who have already responded to our appeal for voluntary donations, sent out with the last edition of *Resurrection*.

I apologise that an out-of-date version of the donations request was circulated in error, stating that "*Resurrection* is sent free to all members". This statement is no longer the case.

From autumn 2015, we now ask non-members of BCS who wish to receive copies by post to pay a small annual subscription.

Of course, *Resurrection* is published and accessible at our website at no charge.

BCS pays for distributing our journal *Resurrection* by post to CCS members who are also members of BCS. BCS also meets the costs of running CCS events and associated expenses.

These arrangements are separate from any contribution to the Donations Fund.

It is the generous support of individual members to our donations fund which enables the CCS to provide the ongoing support needed for our computer restoration projects and other working groups.

For example, we funded the costs of rescuing the ICT 1301 when it was evicted from its former home in a Kentish barn and taken to the National Museum of Computing.

Members have responded generously in the past, and we are very grateful to the many individuals who donate in this way.

Donations, made payable to "British Computer Society" may be sent to

Dr David Hartley,
The Treasurer, Computer Conservation Society,
22 Applecourt,
Newton Road,
Cambridge, CB2 8AN.

Thank you very much indeed.

In Unlikely Places

Dik Leatherdale

It is, please understand, *Mrs* Editor who is keen on stately homes. So we are, of course, National Trust members and occasional visitors to various magnificent old piles. Not, you may think, the most fruitful ground upon which to discover anything of interest to seekers after knowledge of historic computers, though I can claim to having once spotted a Ferranti television on the premises.

But consider *The Homewood* in Esher, a 1930s "modern" house in the minimalist style of Le Corbusier designed and occupied by the late architect Patrick Gwynn who kept the building and its contents up to date well into the 1990s. The guided tour starts in his drawing office. A drawing board, various instruments and something quite unexpected — a computer with a telephone handset attached. Not as you might expect, an ICL One-Per-Desk, but something altogether rarer, an STC Executel, a device previously unknown to me, and perhaps to you gentle reader.

The STC Executel © The Museum of Technology

Launched in 1983, a little before the STC takeover of ICL, and bearing only a superficial relationship to what ICL insiders called the "Wunper", the Executel was described by esteemed CCS member and originator of the OPD, John Panter as "a telephone with a computer as against a computer with a telephone", which is perhaps what you might expect from STC (Standard Telephones and Cables) and ICL (International Computers) respectively.

The Executel boasted a small repertoire of in-built software — a personal directory, a diary, access to Viewdata, a calculator, a clock and various other functions. But lacking an operating system there was no possibility of add-ons — you got what you were given, no more, no less. The software repertoire of the Sinclair QL-derived ICL OPD, by contrast was expandable not only by ICL, but also by third parties and it had the not inconsiderable advantage of a reasonably sized monitor which, as you can see from the illustration, the Executel did not.

The division of capability was not unlike the contrast between a present-day smartphone and an "ordinary" mobile 'phone.

The ICL One-Per-Desk

One thing which will be immediately apparent to the reader is that the Executel looks to have been more expensively built than the OPD — metal is in evidence, in contrast to the OPD's plastic. Consequently Executel retailed at around £3,000 a throw, roughly twice the price of the OPD. And it was the price which seems to have been its downfall with sales which could only optimistically be described as better than "dismal". Why would anybody pay twice as much for what was, after all is said and done, a less capable device without even the possibility of a printer?

The OPD by contrast, sold in its tens of thousands not just by ICL, but also by British Telecom which re-branded it as "Tonto" (Spanish for "silly" since you ask). At the end of its sales life, the unsold OPD stock was distributed amongst ICL middle managers pending the arrival of a flood of PCs. But such was the residual demand from customers that within a few months, they were all collected up again and sold (the OPDs that is, not the middle managers).

But OPD had not one but two Achilles' heels. Although ICL engineers did manage to improve the poor reliability of the Sinclair Microdrives (think miniature 8-track cartridge player) a popular third-party add-on was a floppy disc drive, not least to improve performance. More seriously the power supply unit was all too frequently vulnerable to failure and usually proved fatal after a few years.

A plausible theory popular on the Web is that Executel was a development of OPD. This is categorically untrue. Both were developed before the STC/ICL "merger" and Executel was launched first.

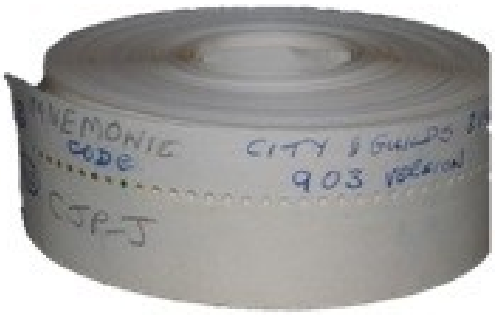
So when "culture" threatens, embrace it. Who knows what may turn up?

City and Guilds Mnemonic Code

Andrew Herbert

City and Guilds Mnemonic Code is a machine-independent assembly code created by the City and Guilds Institute to enable practical programming questions to be included in the examination for their basic and advanced Certificates for Computer Personnel (courses 319 and 320 respectively). The courses were introduced in 1964 and revised in 1968 when course 319 was renamed "Certificate in Computer Programming and Information Processing".

Very little trace of Mnemonic Code remains: searching the World Wide Web throws up a few reminiscences of people who used it as students, but no detail of the language itself. There is an ICL 1900 implementation (#XMS3) being resurrected by Brian Spoor, who has obtained a printed course specification, copyright date 1967, which contains a language definition.



I have been fortunate to obtain a copy of the Elliott 903 version via Mr Chris Pugh-Jones who contacted me after a previous *Resurrection* article I wrote about Elliott 903 software. Mr Pugh-Jones has a collection of paper tapes for both Elliott 803 and 903 computers dating from his student days and one of these had a written label "**MNEMONIC CODE CITY & GUILDS 319 903 VERSION**" and a punched legible heading giving the same information plus "**ISS 1**" — i.e., Issue 1. The tape was accompanied by a typescript sheet listing the program entry points.

Sadly the tape did not read under initial instructions on a real 903. Investigations by myself and Terry Froggatt using our 903 simulators and associated tools found the tape to be a loader followed by a store image, but with a corrupted initial section (5 missing rows). Terry corrected this and we then had a tape that would read in and execute programs successfully. The loader was different to the other Elliott loaders we have encountered. To document the program we both set about analysing it. We now have a source that can be assembled using Elliott

903 Symbolic Input Routine to produce an identical store image to the original tape.

Subsequently, Terry obtained two tapes labelled "**C & G Compiler**", master and copy respectively, from the Museum of Scotland. Apart from the omission of a legible header these are identical to the corrected Pugh-Jones tape and so it can be reasonably assumed we have recovered the definitive Elliott 903 system for running City and Guilds Mnemonic Code.

The missing rows on the original tape are a mystery – the rows are physically missing, rather than damaged or unreadable suggesting some error when the tape was originally punched.

Mr Pugh-Jones also found in his archives a printed specification of the "Revised Mnemonic Code (1968)" which defines an extended order code compared to that in the document circulated by Brian Spoor so it is assumed this earlier document relates to the original 1964 specification.

Mnemonic Code

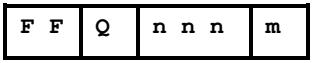
Mnemonic Code comprises assembler directives, machine orders (instructions) and numbers. Data is held internally in floating point form.

The code assumes a computer with 1,000 words of store. Each word can contain an order, a (floating point) number or a character for input/output. The architecture requires integers to be held with at least 7 digits precision.

The order code is of the single address form. The first 10 locations of store are reserved for registers. Location 0 always contains the value 0; it cannot be updated. Location 1 is the accumulator (A). Location 4 is used to hold the return link when entering a subroutine. All the registers can be referenced as index registers.

In addition to the index registers there is also a control register (C) that contains the address of the next instruction to be executed. Unless updated by a jump instruction C is automatically incremented after each instruction is executed.

An order comprises four fields expressed as a seven digit number:



1. Order number F
2. Address n
3. Modifier m
4. Trace Q

The order number specifies the function to be performed as listed below. The machine is unusual in having orders for mathematical functions, but these could be thought of as "extracodes" as found in machines such Atlas.

The address is a natural number in the range 0-999.

The modifier is a natural number in the range 0-9 and, for orders that support modification, the effective address is computed by adding the content of the address field to the content of the nominated index register (i.e., store location). Thus, using 0 as the modifier yields the address field unmodified. Note that, since the contents of store comprise floating-point numbers, the value of the index register has to be rounded before it is added to the address field.

The interpretation of the trace field is implementation dependent, but indicates that some sort of diagnostic output should be produced whenever the instruction is executed.

Numeric Function	Mnemonic	Operation	Remarks
00	**LDA n, m**	A:=(n+(m))	Load operand into cleared accumulator
01	**ADD n, m**	A:=(A)+(n+(m))	Add operand
02	**SUB n, m**	A:=(A)-(n+(m))	Subtract operand
03	**MLT n, m**	A:=(A)*(n+(m))	Multiply by operand
04	**DIV n, m**	A:=(A)/(n+(m))	Divide by operand
10	**LDAN n**	A:=n	Load integer
11	**ADDN n**	A:=(A)+n	Add integer
12	**SUBN n**	A:=(A)-n	Subtract integer
13	**MLTN n**	A:=(A)*n	Multiply by integer
14	**DIVN n**	A:=(A)/n	Divide by integer
20	**STA n,m**	n+(m):=(A)	Store (A) without clearing accumulator
30	**JUN n, m**	C:=n+(m)	Jump unconditionally
31	**JGR n, m**	If (A)>0 C:=n+(m)	Jump if A>0
32	**JEQ n,m**	If (A)=0 C:=n+(m)	Jump if A=0
33	**JSR n, m**	4:=Link; C:=n+(m)	Set link and jump; link is the address of the instruction following JSR
34	**JST n, m**	Wait; C:=n+(m)	Wait; jump when start button operated
40	**SQT n, m**	A:=sqrt(A)	If (A)<0, jump to n+(m)
41	**EXP n, m**	A:=exp(A)	If (A) too large jump to n+(m)
42	**LGN n, m**	A:=ln(A)	If (A)<0, jump to n+(m)
43	**SIN**	A:=sin(A)	(A) in radians
44	**COS**	A:=cos(A)	(A) in radians
45	**ARC**	A:=arctan(A)	(A) in radians

46	**ENT**	A:=entier(A)	Integral part of (A) to A
50	**RCT n, m**	character to n+(m)	Read single character from tape
51	**PCT n, m**	(n+(m)) to tape	Punch single character to tape
52	**RNT n, m**	number to A	Read number from tape; jump to n+(m) if error in the number
53	**PNT n, m**	(A) to tape	Print signed number in A to tape with n integral and m fractional digits
54	**PNL**		Punch the characters for new line
60	**RCC n, m**	characters to n+(m)	Read characters from card
61	**PCC n, m**	(n+(m)) to card	Punch characters to card
62	**RNC n, m**	number to A	Read number from card; jump to n+(m) if error in the number
63	**PNC n, m**	(A) to tape	Print signed number in A on to card with n integral and m fractional digits

If an instruction is followed by the letter Q, the trace digit will be set.

The 1968 specification changes the specification of some orders and adds additional ones, mostly concerned with a richer input/output model as tabulated below.

Numeric Function	Mnemonic	Operation	Remarks
10	**LDAN n**	A:=n+(m)	Load integer
11	**ADDN n, m**	A:=(A)+n+(m)	Add integer
12	**SUBN n, m**	A:=(A)-n+(m)	Subtract integer
13	**MLTN n, m**	A:=(A)*n+(m)	Multiply by integer
14	**DIVN n, m**	A:=(A)/n+(m)	Divide by integer
31	**JEQ n, m**	If (A)=0, C:=n+(m)	Jump if (A)=0
32	**JNE n, m**	If (A)<>0, C:=n+(m)	Jump if (A)<>0
33	**JLE n, m**	If (A)<=0, C:=n+(m)	Jump if (A)<=0
34	**JGE n, m**	If (A)>=0, C:=n+(m)	Jump if (A)>=0
35	**JLT n, m**	If (A)<0, C:=n+(m)	Jump if (A)<0
36	**JGR n, m**	If (A)>0, C:=n+(m)	Jump if (A)>0
37	**JSR n, m**	As above	
38	**JST n, m**	As above	
39	**LOP n, m**	If (5)>0 after (5)-1, C:=n+(m)	Jump if after subtracting 1 from location 5, (5)>0
50	**ARD n, m**		Allocate input device n+(m) to program
51	**AWD n, m**		Allocate output device n+(m)

			to program
52	**RNA n, m**	A:=number	Read number; jump to n+(m) if error in number
53	**WNA n, m**	Write (A)	Write (A) with n integral and m fractions digits. If n and m are zero, floating point is implied
60	**RCH n, m**	Read one character to n+(m)	Read character to store
61	**WCH n, m**	Write one character from n+(m)	Write character from store
62	**RNB n, m**	Read characters to n+(m)	Read block of characters into locations starting at n+(m)
63	**WNB n, m**	Write characters from n+(m)	Write block of characters from locations starting at n+(m)
64	**WNL n, m**	Write n+(m) newlines	
65	**WSS n, m**	Write n+(m) spaces	
66	**CNN n, m**	Convert character string to number	String starts at location n+(m); result put in A
67	**CNC n, m**	Convert number to character string	Number is in (A); string starts in location n+(m) onwards
70	**ACB n, m**	Access block n+(m)	For direct access devices n+(m) defines the sector; for other devices the effect is to skip n+(m) blocks
71	**BSP n, m**	Backspace n+(m) blocks	
72	**RWD**	Rewind device	
99	**STOP**	Stop	Return control to operating system

The revised specification also defines a collating sequence for characters since these can be manipulated as numbers in this version of the language.

There are 4 directives to the assembler:

(TITLE) Reads the next line as the program title and copies to the output.

(STORE n) Stores the following program from location n onwards.

(WAIT) Pauses input, awaiting a further program tape to be input.

(EXECUTE n) Marks program complete and sets location n as the location at which execution should commence.

Note there are no facilities for giving textual names to store locations (i.e., labels) or any form of relative addresses: all addresses in a program are absolute. Nor are there facilities for literal addresses – i.e., writing a numeric value in the address field and having the assembler automatically allocate store to hold the value. This makes program structure very fragile – adding or removing an instruction or number can require wholesale editing. This is a major omission and great inconvenience to the programmer. The lack of any form of comment facility further compounds the opacity of programs.

The Elliott Implementation

Terry Froggatt has a sales brochure dating from 1967 that mentions the availability of "City and Guilds 319 compiler" so it is assumed the system was distributed by Elliotts. Whether the program originated in-house or not is unknown. There is circumstantial evidence that the compiler may have originated on an Elliott 920A, a predecessor of the 903/920B.

The Elliott implementation of Mnemonic Code is very straightforward, comprising an assembler, an interpreter and an editor. There are two primary entry points: one to read in and assemble a Mnemonic Code source paper tape (entry at location 8) and the second to run a previously assembled program (entry at location 9). These are set up by setting the address on the 903 control panel keys and pushing the JUMP button. There are secondary entry points to enable a program made up of several tapes to be read in (Interrupt 1), to resume execution after a stop (Interrupt 2) and to enable execution tracing for debugging purposes (Interrupt 3). These are exercised by pressing the appropriate manual interrupt button on the control panel.

Example program

```
(TITLE)
SIMPLE TEST
(STORE 12)
LDAN 1
ARC 16
MLTN 4
PNT 1,6
JST
(EXECUTE 12)
```

Output

```
SIMPLE TEST
 3.141593
```

All input and output is in Elliott 903 telecode, an ancestor of ASCII. The language implemented is the simpler 1964 version. The card reader and punch instructions are not supported as the 903 is a paper tape based machine.

The interpreter has an internal character code which is neither 900 telecode (with or without parity) nor the 6 bit code used by other Elliott software (e.g., the Algol compiler). Nor does the code comply with the collating sequence given in the 1968 specification. It does however show some similarity with the earlier flexowriter code used on the Elliott 503 and 920A.

The assembler makes comprehensive checks of the input source, but halts after each error report, which consists of an error number and the store location in which the next instruction or datum will be loaded. In principle the operator can re-enter the assembler to move past the error but this becomes a tedious procedure especially if there are a lot of errors in the input.

Typical error report

```
ERR  2     12
```

The interpreter also makes comprehensive checks to ensure that programs do not address outside of the available store and also that no attempt is made to treat instructions as data or vice versa. (The latter is not a requirement in any of the language specifications and rules out writing any sort of assembler or loader in Mnemonic Code, arguably a significant restriction). Execution errors are reported as a numerical error type code followed by the location of the failing instruction.

Internally the interpreter does not use the function codes given in the language specification: instructions cannot be processed as data so this is not visible externally.

When tracing is enabled, execution of any instruction in which the Q field is set produces a line of output showing the current value of the control register (i.e., program counter) and the accumulator.

Typical trace output

```
Q   16   9.000000?+00
Q   16   8.000000?+00
Q   16   7.000000?+00
Q   16   6.000000?+00
Q   16   5.000000?+00
Q   16   4.000000?+00
```

Floating point arithmetic in the interpreter uses what appears to be an early issue of the standard Elliott QF/QFMATH/QFINOUT packages.

The editor is effectively a separate program co-resident in store with the assembler/interpreter and has entry points to read in a steering tape followed reading in a source tape for editing.

The editor would appear to be based on the Elliott EDIT utility. It has simple commands to copy, insert and delete text, searching by line or character string. Unlike EDIT it lacks the facility to read back and check the output tape has been punched correctly.

Concluding Remarks

Following recovery of a paper tape for the Elliott 903 implementation of Mnemonic Code it has been possible to reverse engineer the system and compare to the City and Guilds Institute specification. There are some minor divergences but the system is clearly suitable for running 1964 C&G Mnemonic Code programs on a 903.

Mnemonic Code itself is an impoverished assembly language and the choice of floating point as the basic data format is unconventional. The code can at best be used for numerical calculations. Any sort of textual or logical processing is inconvenient if not nigh on impossible. It is not surprising that has almost disappeared without trace, and indeed the author feels some guilt at resurrecting it.

Following an exciting and senior computing career Andrew Herbert is now Project Manager for the EDSAC Replica Project at TNMoC. He can be contacted at andrew@herbertfamily.org.uk.

CCS Website Information

The Society has its own website, which is located at *www.computerconservationsociety.org.* It contains news items, details of forthcoming events and also electronic copies of all past issues of *Resurrection*, in both HTML and PDF formats, which can be downloaded for printing. We also have an FTP site at *www.cs.man.ac.uk/CCS/Archive/*, where there is other material for downloading including simulators for historic machines. Please note that the latter URL is case sensitive. Kindly also note that this URL changed in 2014 so it is given incorrectly in *Resurrection 65*-.

ICL 7903 & 2812 Emulation

Bill Gallagher

The GPC — rarely known by its original name.

The *General Purpose Controller* (generally known as the GPC) was a 16-bit programmable controller designed and produced by ICL in the late 1960s and was better known as a disc controller (model 2812) or a communications controller (model 7903), mostly on the larger 1900 series computers, but also, for compatibility, on some of the early 2900 systems. It was called the GPC — General Purpose Controller on documents such as the logic diagrams and the various technical descriptions to which we are fortunate to have access. This GPC should not however, be confused with the ICL 2900 General Peripheral Controller (also commonly referred to as the GPC). As a programmable controller, its function was controlled by its own operating system, known as a DCP — Dedicated Control Program. The machine was also known quite widely as the PF56.

ICL 7903 & 2812 Emulation

As part of a project to preserve the 1904A/S machines via emulation, we have achieved some success in creating an emulation of the GPC hardware. The emulator was created based on the original microprogram steps and was, in some ways surprisingly easy to get working. This was due to ICL's quite detailed documentation, the only difficulty being the descriptions were written for an audience already fairly familiar with the material.

The intention of the GPC project is to create an emulated 2812 or 7903 processor that can connect to our emulated 1904S system in order to provide an environment where original ICL Executives, GEORGEs, DCP and ancillary equipment run with no alteration and in a manner as close as is practical to the original.

The Beginning: DCP Recovery

The project, in a way, grew out of a smaller project where I was creating an inventory of available resources for the 1900 series. We had two magnetic tape images with 2812 DCPs on it and a GEORGE3 file that on investigation proved to have a copy of the 7903 DCP (**`#EZ5A`**). After a number of runs of various utility programs we extracted all of the DCPs, OLTs (OffLine Test programs) and some 1900 utility programs to manage them and to print post-mortems.

First Steps – Understanding the Instruction Set.

The only sources of documentation were in some reference cards and in the technical description of the processor. Unfortunately these sources disagreed with each other regarding certain details, and in some cases omitted critical information altogether — they were not ever intended to be used for 'ab initio' training, so I won't complain. My first attempt several years ago to emulate the GPC proved unsuccessful due largely to a lack of understanding of the instructions on my part. That project was set aside and we concentrated on getting the 1904S emulation to pass **#FLIT** (the Functional and Logical Instruction Test program) diagnostics etc.

Assembling the Parts

Among the various items available was a 1900 program listing for **#SPAA** — the assembler for the GPC. This was re-keyed, and debugged to get my typing errors out and that was where I had intended to stop, simply with a folder with a toolkit of items so that we could return to it later. However I was looking at the technical description document and realised that there was a great deal of information there and I wrote a couple of small test routines in C++ to simulate some of the actions of the MILL; these were to become the basis of the current emulation. Over a few weeks a framework based on these routines and using Windows™ as the interface to provide a rudimentary form of a work-alike for the controls on the machine evolved. When the GUI started to work, I realised how well thought out the GPC user interface was. It allowed the operator/engineer to inspect the processor and its peripherals in considerable detail, without resorting to the vast expense of a 'light map' as used on the 1904S, which used over 1000 fluorescent indicator valves.

Progress was then punctuated by re-keying the available diagnostic sources and assembling them. Each failure (and a few false passes) had to be checked against the original listing for typing errors (all mine!). In the last few weeks it became possible to at least load the actual DCPs into the machine and start them. This revealed that the console I/O was completely wrong! I keep thinking in terms of later machines and assuming things work as many machines do now. Thanks Brian for the reminders that despite their size these machines were in a way simple. Some time spent examining the routines in the DCPs that handle typewriter input & output have so far only proved partially fruitful: I still have to compile the emulator program with the 'hardware' acting differently for 2812 DCPs and 7903 DCPs.

The approach of using the original microprogram and register structure whilst initially confusing, has paid several dividends. The diagnostic sources available refer to specific steps and signals in the commentary and on a number of

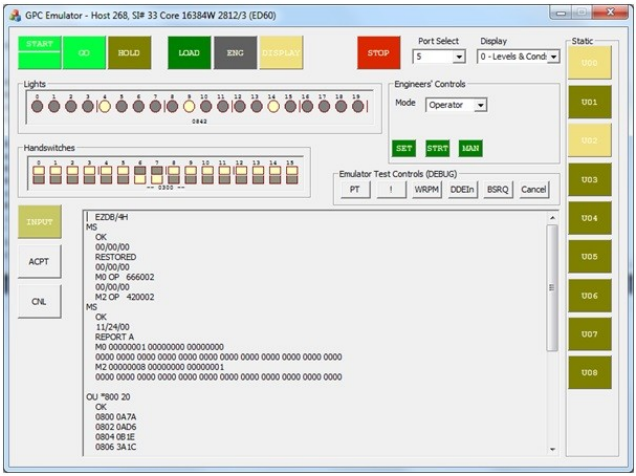
occasions the original ICL diagnostic programs have correctly indicated where I made a mistake!

Further development will probably slow down until the autumn, I will conclude by saying thank you to everyone who has provided documentation and the software artefacts that have enabled what has turned out to be fascinating project.

Progress with DCPs

The 2812 disc DCP #EZDB runs and can perform some disc I/O transfers successfully:

```
   EZDB/4H
MS
   OK
   00/00/00
   RESTORED
   00/00/00
   M0 OP    666002
   00/00/00
   M2 OP    420002
OU 16 5
   OK
   0010 36A6
   0012 4F5A
   0014 0C8C
   0016 2B3A
   0018 0003
MS
   OK
   11/40/00
   REPORT A
   M0 00000001 00000000 00000000
   0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
   M2 00000008 00000000 00000001
   0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
```



Screenshot of the 2812 emulator in action

Similarly the **#EZ5A** Communications Processor DCP can be said to start running.

```
EZ5A/7/A/ST2
  32K STORE
  _U0  OK
  _E  OK
  _L0 D7071 I1 M4  OK
  _L1 D7071 I2  OK
  _L4 D7181 I8 A40 S2400  OK
  _L5 D7181 I9 A50 S1200  OK
  _L6 D7181 I9 A50 S1200  OK
  _L12 D7023 I17 A63  OK
  _L12  D7021 I18 A62  OK
  _OP  OK
  _POLL D7181 4  OK
  _END  OK
  DCP READY
  *120E SCANNER 0    WRONGED(*00CD)
  SA0DS00A/7A READY
OU 16 4  OK
  *0010 *0AAE
  *0012 *0E32
  *0014 *1CCC
  *0016 *1D0E
TP  OK
  T#SA0DS00A
ST 1  OK
  L0 0 0
RI 6  OK
  *120E SCANNER 0    WRONGED(*00CD)
ON 5 9  OK
OU 108  OK
  *006C *0440
ON 0  OK
OU 108  OK
 *006C *8440
ID 1  OK
  *73D6
ID 2  OO
  *73FC
ID 8  OK
  *7446
ID 9  OK
  *7494
ID 8 9  OK
  *7446
LI 0  OK
  *73CA
LI 4  OK
  *7416
CH 0  OK
  *0000
CH 1  OK
  *0001
IT  OK
IT 1  OK
AL 108 0  OK
OU 108  OK
  *006C *0000
AL  108 *FFFF  OK
OU 108  OK
  *006C *FFFF
OF 9  OK
OU 108  OK
   %%
*006C *FFBF
TE 1  OK
  TESTING 1
RE  OK
  DCP READY
  *120E SCANNER 0    WRONGED(*00CD)
OU 108  OK
 *006C *FFBF
```

We have the processor running well enough to satisfy the available diagnostic programs:

SA00PUIJ Initial jump tests
SA00PUFA Initial functions
SA00PUIL Interrupt levels
SA00PUFA General functions

However the I/O in most of its manifestations is proving rather reluctant. Whilst the screen shots above might indicate that the console is working, it occasionally misses typed characters and I suspect that the output layout is suspect.

The paper tape reader works fine to load the WUSH (a simple binary format) images and to load binary format tapes under **#EZDB**, but I cannot get it to work under **#EZ5A**, which explains why I had to load the specification via the console.

The DDE/IPM module responsible for communication with the parent 1900 machine works only in so far that I can send faked data segments into and receive them from it. This module I think I understand reasonably well as we have the 1900 exec side code to see what's being sent and expected.

As for discs, I can currently read disc blocks, write disc blocks and even format cylinders, so it is working, even if in a rather slow and unreliable manner. Disc diagnostic tests can be loaded from the disc, but figuring out how to operate them is a job for later.

I have only just started to examine the MCIU and scanner interface and so cannot comment much on it. Although we have received the **DCP READY** and **SA0DS00A READY** messages, the lack of emulated communications hardware prevents any meaningful progress for now.

An appeal for help:

We would be interested and grateful if anyone who might have any material related to the PF56/2812/7903 would consider making it available – documents, listings, paper tapes, scribbled notes, everything is valuable.

Bill Gallagher is a self employed IT consultant and 1900 series enthusiast. He previously worked with Wang and Digital computers and can be contacted at bill.gallagher@augharue.eu.

40 Years Ago ….
From the Pages of Computer Weekly
Brian Aldous – TNMoC Archivist

System to improve white blood cell analysis: A system that could ultimately revolutionise the organisation of haematology departments in hospitals and research centres has been released in the UK by the medical division of the US corporation, Corning Glass. It is the first computer system designed specifically for operation by trained medical staff to function as a tool within the hospital. (CW461 p7)

Nixdorf bid to challenge System 32: The German manufacturer Nixdorf has made a bold attempt to increase its market penetration in the US with the introduction there of an American version of the 8870 small business system, announced in Europe at the end of last year, but still not available in the UK. (CW462 Intl Ed p24)

Natwest offers 24-hour on-line service: The first major on-line banking system offering services outside bank premises is to be set up by the National Westminster Group using NCR 770 financial terminals. The bank has ordered 100 units, worth over £1.5m, to be installed outside selected branches and at remote sites and linked on-line to Natwest computer centres at Kegworth, Derbyshire, and at Woolgate House in the City. (CW462 p32)

Datasaab and CTL to share in maintenance: An imaginative co-operative venture has been established by Computer Technology and Datasaab to pool their service and maintenance resources in such a way as to enable both companies to achieve a wider geographic coverage and faster response, and benefit from economies of scale. (CW463 p3)

Add-on memory 'undercuts ICL': Something of a marketing breakthrough has been claimed by Systems Reliability, of Luton, which has just added 32K of its monolithic memory to an ICL-maintained 1902A operated by Tucker Fasteners, a Birmingham manufacturer of industrial fasteners. (CW 463 p21)

Viewdata to be based on GEC 4080: Although news of the Post Office's latest telephone information service has been in the air for some time, the capabilities of this new interactive system were not made known until this week at the Eurocomp conference. At the same time an order for a GEC 4080 computer, on which the Viewdata system will be based, has been placed by the Post Office. (CW464 p40)

Telex gives up the fight: The great IBM-Telex anti-trust saga came to an abrupt end on Friday when Telex announced it had withdrawn its petition to the US Supreme Court for a rehearing of its suit against IBM. (CW466 p1)

The dominant technology: The annual dinner of the British Computer Society held last Friday evening was marked by the attendance of the Duke of Kent, as a guest of honour. In a well-informed speech the Duke avoided the solecisms to which the layman speaking about computers is so frequently prone, and commented that "We are not far from the point, if we have not already reached it, where computing is the dominant technology of today's world". (CW466 p1)

EMI wins £2m NHS order for scanners: A world leader with its computer controlled brain scanner system, EMI has scored its latest sales success in the UK, securing an order for 15 systems, worth £2 million, from 15 hospitals in England and Scotland. (CW466 p6)

Micro family from Texas Instruments: A family of 16-bit microprocessors and microprocessor-based computers, together with fully compatible software, has been announced by Texas Instruments. Known as 990/9900 family, the units were developed at the company's Houston location and are scheduled for first deliveries in the UK from next March onwards. (CW467 p3)

ICL goes for the small systems market: In a bid to win a share of the potentially lucrative market for small business systems, ICL plans to launch a machine known as the 2903/20 next month. Aimed essentially at the small first time users, the new system is a considerably scaled down version of the highly successful 2903, which now gets the designation 2903/40. (CW468 p1)

Plessey building £2m ATC radar project: A major air traffic control contract, involving some 60 Digital Equipment PDP-11 minicomputers, and worth £2 million, has been awarded to Plessey by the Civil Aviation Authority. (CW468 p40)

Users win round in disc battle: ICL users have won the first round in a battle to make large scale disc drives available for use with pre-2900 series computers, and a decision on this point is expected from the company before the end of the year. (CW472 p1)

Siemens seeks Fujitsu deal: Following the collapse of Unidata, Siemens is seeking to counter its weakness at the top end of its current range by concluding a deal with Fujitsu. According to a report in the Japanese newspaper Nikkan Kogyu Shinbun, an agreement in principle has been reached whereby Siemens will assemble the M190, Fujitsu's version of the Amdahl 470. (CW473 p1)

Triad to market the NPL Scrapbook system: Many ingenious software products are hatched within government and university research departments and are regrettably never commercially exploited. As a refreshing exception to this rule, the National Physical Laboratory's novel Scrapbook textual information handling system is now to be generally released through Triad Computing Systems. (CW473 p9)

Forthcoming Events

London Seminar Programme

22nd Oct 2015	Understanding Colossus	Chris Shore
19th Nov 2015	The History of Primary Care Computing	Group from PHCSG
17th Dec 2015	Computer Films	Dan Hayton & Terry Froggatt
21st Jan 2016	The Unknown Turing	Sir Dermot Turing
18th Feb 2016	Ada Lovelace	Doron Swade

London meetings normally take place in the Fellows' Library of the Science Museum, starting at 14:30. The entrance is in Exhibition Road, next to the exit from the tunnel from South Kensington Station, on the left as you come up the steps. The February meeting is likely to be the last at this venue. Details in the next edition of *Resurrection*.

For queries about London meetings please contact The CCS secretary Roger Johnson (page 36 for contact details).

Manchester Seminar Programme

20th Oct 2015	A Short History of Computing at the Met Office	Chris Little
17th Nov 2015	Evolution of Microcode Development	John Eaton
19th Jan 2016	A Short History of Information Security Technologies	Mike Small
16th Feb 2016	Structured Software and the Break with Electrical Engineers	David Grier

North West Group meetings take place in the Conference Centre at MSI — the Museum of Science and Industry in Manchester — usually starting at 17:30; tea is served from 17:00. For queries about Manchester meetings please contact Gordon Adshead at *gordon@adshead.com.*

Details are subject to change. Members wishing to attend any meeting are advised to check the events page on the Society website at *www.computerconservationsociety.org/lecture.htm*. Details are also published at in the events calendar at *www.bcs.org.*

In addition to the dates above, it is planned to visit the Berlin Technical Museum on 15th-17th April 2016 to view, amongst other things, the replica Z1 automatic mechanical calculator built by Konrad Zuse. Our host will be Prof. Horst Zuse who has memorably spoken at CCS meetings on the subject of his father's work.

Museums

MSI : Demonstrations of the replica Small-Scale Experimental Machine at the Museum of Science and Industry in Manchester are run every Tuesday, Wednesday and Sunday between 12:00 and 14:00. Admission is free. See *www.mosi.org.uk* for more details.

Bletchley Park : daily. Exhibition of wartime code-breaking equipment and procedures, including the replica Bombe, plus tours of the wartime buildings. Go to *www.bletchleypark.org.uk* to check details of times, admission charges and special events.

The National Museum of Computing : Thursday, Saturday and Sunday from 12:00. Situated within Bletchley Park, the Museum covers the development of computing from the wartime Tunny machine and replica Colossus computer to the present day and from ICL mainframes to hand-held computers. Note that there is a separate admission charge to TNMoC which is either standalone or can be combined with the charge for Bletchley Park. See *www.tnmoc.org* for more details.

Science Museum :

There is an excellent display of computing and mathematics machines on the second floor. The *Information Age* gallery explores "Six Networks which Changed the World" and includes a CDC 6600 computer and its Russian equivalent, the BESM-6 as well as Pilot ACE, arguably the world's third oldest surviving computer. Other galleries include displays of ICT card-sorters and Cray supercomputers. Admission is free. See *www.sciencemuseum.org.uk* for more details.

Other Museums : At *www.computerconservationsociety.org/museums.htm* can be found brief descriptions of various UK computing museums which may be of interest to members.

Contact details

Readers wishing to contact the Editor may do so by email to dik@leatherdale.net, or by post to 124 Stanley Road, Teddington, TW11 8TX.

Members who move house or change email address should notify Membership Secretary Dave Goodwin (dave.goodwin@gmail.com) of their new address. Those who are also members of BCS, however, need only notify their change of address to BCS, separate notification to the CCS being unnecessary.

Queries about all other CCS matters should be addressed to the Secretary, Roger Johnson at *r.johnson@bcs.org.uk*, or by post to 9 Chipstead Park Close, Sevenoaks, TN13 2SJ.

Committee of the Society

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