ATLAS@50

Then and now

Science & Technology
Facilities Council

Foreword

It is now known as Rutherford Appleton Laboratory buildings R26 and R27, but over its 50+ year history, the Atlas Computer Laboratory in the parish of Chilton has been part of many seminal moments in computing history.

Over its 50+ year history it has also housed many mainframe and super-computers including the Ferranti Atlas 1, a Sigma 2, a PDP15, an ICL 1906A, two IBM 360/195s, an Atlas 10, and three Crays (an X-MP, a Y-MP and a J90). These machines have all been decommissioned now, but the consoles of the Atlas 1, one of the IBM 360/195s and half the Cray X-MP have been preserved together with a physical archive of papers, manuals and other artefacts, and a virtual archive known as the Chilton Computing web site.

The console of the Atlas computer was rediscovered in July 2014; it had been languishing in storage for so long that even the paperwork had been forgotten.

It was cleaned and restored as far as we could, and took pride of place at an event held to celebrate the 50th anniversary of its inauguration. It now makes occasional appearances at other events held at Rutherford Appleton Laboratory.

This publication attempts to capture something about what made the Ferranti Atlas 1 super-computer, the building which housed it, and the people who worked on it, such a significant part of British computing history.

The origins of Atlas

In the years following the Second World War, there was huge interest in nuclear physics technologies both for civilian nuclear energy research and for military nuclear weapons. These technologies required ever-increasing amounts of computer power to analyse data and, more importantly, to perform simulations far more safely than would be possible in a laboratory. By 1958, 75% of Britain's R&D computer power was provided by the Atomic Energy Authority (UKAEA) at Aldermaston (using an American IBM 704), Risley, Winfrith and Harwell (each using a British Ferranti Mercury).

These were however what we would now call single-user systems, capable of running only one program at a time, so were essentially very large desktop calculators. Indeed, the name "computer" referred to the human operator; the machinery itself was known as an "automatic calculating machine."

British manufacturers of automatic calculating machines were doing well until IBM announced that their first transistorised computer was to be launched in a couple of years' time in 1961. This was the model 7030, known as STRETCH, which would cost $13.5M and (according to the marketing hype) be two orders of magnitude faster than their current IBM 704 model. (As it turned out, the performance of STRETCH was disappointingly only six times faster, and the price was dropped to $7.78M.)

Britain was now in danger of losing its competitiveness so at a meeting in January 1957, Lord Halsbury, Director of the National Research Development Corporation (NRDC), announced an ambitious £1M project to develop a new British high-performance computer – a super-computer to rival STRETCH.

He had some doubts however: *"Are we strong enough to compete? Ought we to try? Could we afford not to?"*

The advisory panel for the super-computer included Freddy Williams (a pioneer in radar and computer technology) from Victoria University of Manchester, Maurice Wilkes (designer of EDSAC, the Electronic Delay Storage Automatic Calculator) from Cambridge, Albert Uttley of the RRE (Royal Radar Establishment), and Ted Cooke-Yarborough (designer of the Dekatron and CADET computers) from AERE Harwell; Christopher Strachey (a pioneer in programming language design) was in charge of design.

FERRANTI

Ferranti Ltd was a family-run British electrical engineering and equipment firm established in 1885, with its HQ in Manchester. It specialised in building high voltage transformers and other equipment for the electrical grid, in domestic "brown goods" such as televisions, radios, and electric clocks, and was a major developer of radar systems, defence electronics and avionics during the Second World War. In the 1940s and 1950s, Ferranti collaborated with various university research groups to develop a series of computers including the Ferranti Mark 1, Pegasus, Orion, and a solid state version of the Mark 1 known as Mercury.

Professor Tom Kilburn at the
Atlas Engineer's console, Manchester.

Ceremonial inauguration of the first Atlas computer, Manchester, 7th December 1962.

Pictured are Sir John Cockcroft (seated), Sebastian de Ferranti andTom Kilburn.

The plan was that development contracts would be placed with universities and government departments, and various manufacturing companies including EMI, English Electric and Ferranti were approached to build the machine. Their responses were mixed. English Electric were uninterested; EMI and Ferranti were more enthusiastic, but they and AERE Harwell had concerns about the proposed design, about the management of the project, the expense, and the financial viability of the end result.

Frustrated by the lack of progress, the Second Harwell Computer Conference was held in February 1958 (the first was held in April 1957) between AERE Harwell, NRDC, RRE, the National Physical Laboratory (NPL), the Ministry of Supply (later the Ministry of Defence), and the universities of Cambridge and Oxford. Two recommendations were made to try and get the super-computer project moving again: a short-term project to assess MUSE (the MicroSecond Engine designed by Professor Tom Kilburn at the Department of Electrical Engineering at Victoria University of Manchester), and a longer-term project to develop new components and techniques.

These ideas also met with a mixed response. Although MUSE was thought to be a good basis for further development, its performance fell short of that required for the super-computer so Tom Kilburn was asked to redesign part of the system. When he realised that he had not been appointed lead engineer on a project involving something he had designed however, Tom Kilburn backed out altogether. The longer-term project also failed to get off the ground.

A few months later, Ferranti and Tom Kilburn's team at Manchester made the decision to take matters into their own hands and to build a large scientific machine based largely on MUSE. This project was supported by John Cockcroft, Director of AERE Harwell, but unsurprisingly NRDC were less enthusiastic as they felt it was incompatible with their aims. It was clear that the need for a super-computer – *any* super-computer – was becoming more pressing, that the Manchester project was making significant progress, and that the NRDC was getting nowhere.

In October 1958 it was announced that the Manchester machine designed by Tom Kilburn was to be called Atlas, and would be built by Ferranti's Computer Division headed by Peter Hall in a former steam locomotive factory in West Gorton. (The premises were spacious, although soot in the electrical components was a constant problem.)

The NRDC had not given up however and awarded a grant of £300K to both Ferranti (with Tom Kilburn as lead designer) and EMI (with Christopher Strachey as lead designer) to pursue the design of two super-computers. Clearly there was a certain amount of professional rivalry, but in the end the EMI project did not happen, and the Ferranti one was in progress anyway. Christopher Strachey was an enthusiastic self-taught designer, but he was not an engineer as Tom Kilburn was; he also had what Maurice Wilkes described as "strong personal views" which could make working with him difficult.

In Manchester, on Friday 7th December 1962, the first production Atlas computer was ceremonially switched on by Sir John Cockcroft.

A second Atlas was shared between British Petroleum (BP) and London University, managed by the University of London Atlas Computing Service (ULACS, or ACS for short).

The third and largest Atlas was installed in the purpose-built Atlas Computer Laboratory in Berkshire (now Oxfordshire), located between AERE Harwell and the National Institute for Research in Nuclear Science (NIRNS) Rutherford Laboratory.

In 1972, it was estimated that the Atlas development project had cost £2M, of which £50K had been contributed by the University. It had been a long and sometimes tortuous project which Sebastian de Ferranti said should have been called BISON (Built In Spite of NRDC).

The London Atlas being Commissioned
at Ferranti, August 1963.

The Ferranti Atlas computer at Chilton

The third and largest Atlas computer was ordered by UKAEA on 22nd September 1961. It cost £3.1M, and Ferranti were understandably so pleased that they hosted a celebratory dinner at The Savoy.

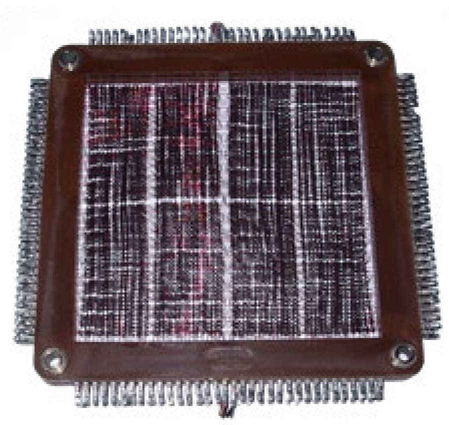
The machine took three years to construct and was finally delivered to its new home in June 1964. It was considered so valuable that it was transported from Manchester using 19 separate trucks so that if there was an accident only one piece would be lost. It was up-and-running just four months later (albeit with an "at risk" service), and by February 1966 it was in full operation 24/7 with three shifts of Operators plus engineering support.

David Burrell at the Engineer's console in the Atlas machine room. To his left is a hardcopy teleprinter and paper tape reader; to his right is a CCTV monitor trained on the tape units upstairs. Behind the console are the power supply units, and behind the engineer are some of the fixed store and CPU cabinets.

Atlas Operations Room. Along the back walls are the two IBM and 16 Ampex magnetic tape drives; in the foreground are two card readers, and in the centre of the room a line printer. Centre right are paper tape readers and a CCTV monitor trained on the Engineer's console. The camera in the ceiling allowed the Engineer downstairs to see what the tape drives were doing upstairs.

The hardware

Atlas was a 48-bit word machine, with 48K of core store arranged in six pairs of stacks, 128 half-words of B store, 8K words of Fixed Store (ROM), 1K words of Supervisor working store, four drums each of 24K words drum store, 16 Ampex TM2 magnetic tape drives, two IBM magnetic tape drives, and 16 Data Products model 5045 file disks each 16.8M word capacity.

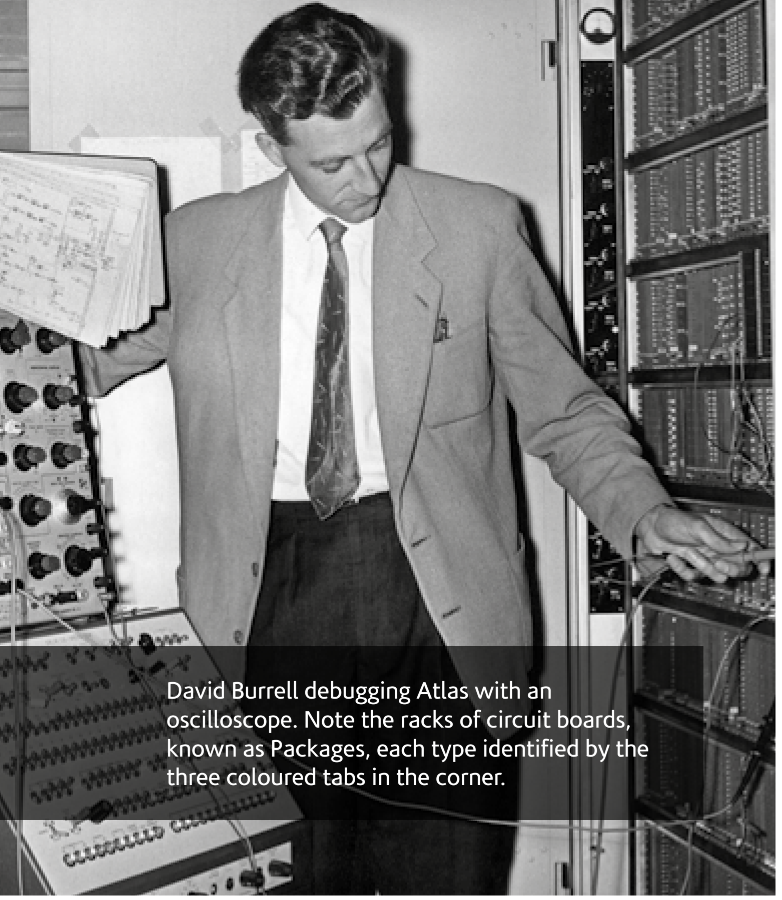


Core store: Core store consisted of Bakelite frames approximately 20cm square containing a 68x68 grid of thin wires with a (magnetic) ferrite doughnut-shaped core at each junction. Each core represented one bit and could be magnetised clockwise or anticlockwise to indicate a binary 0 or 1. Ferrite core is non-volatile – it does not lose its polarity when power is lost – so can resume operation when power is restored. This type of technology was used on the Apollo 11 mission in 1969.

Atlas comprised 768 frames of core store which were manufactured by Plessey at a cost of £600 each. Cost was a major factor in the provision of computer memory as it had to be hand-crafted. There are a variety of stories as to who threaded the cores; some say it was done by lace-makers who were used to such fiddly work, others that it became a cottage industry amongst farmer's wives… but only during the winter evenings because they were too busy the rest of the year.

Fixed store: The crucial interrupt routines of the Atlas Supervisor were held in Fixed Store. Binary 0s and 1s were represented by 34 ferrite or copper slugs set into a mesh known as a Brush. An Atlas word consisted of 1 bit from each of 48 brushes, so once it had been set up, fixed store was read-only, reprogrammed very rarely and always with great care. Fixed store was also used to provide Extracodes – special functions such as sine and square root.

File store: Atlas used 16 Data Products model 5045 discs for file store. Each disc was a meter in diameter (the coffee mug in the photo is for size comparison) and held about 6 megabytes of data. Caution was required when opening the cabinet because the discs were spinning horizontally and were very heavy so could easily decapitate an unwary Operator if they flew off their spindles. Fortunately, this never actually happened!


David Burrell debugging Atlas with an oscilloscope. Note the racks of circuit boards, known as Packages, each type identified by the three coloured tabs in the corner.


Packages: Atlas comprised about 5660 hand-soldered circuit boards or Packages, of several dozen different types. This is Package 926 from the console so is probably part of a device driver. Note that it contains Mullards – a type of transistor based on germanium rather than the faster silicon. Each package had a different function such as adder-input, inverter or flip-flop, and the different functions were indicated by three coloured tabs in the corner. Slots in the racking were marked with the same colours so that if a board was removed it could be replaced in the correct position.

The Supervisor

Different components operated at different rates: Atlas core store had a cycle-time of 2 microseconds, B-store 0.7 microseconds; drum store had a transfer time of 2 milliseconds per block of 512 words, and Ampex magnetic tapes a transfer rate of 90K characters per second.

Much longer waits occur when Operators need to change a magnetic tape, say, or a paper tape running at 110 characters per second needs to finish reading, and automatic calculating machines could run only one program at a time because they were forced to wait for these events to complete before continuing. Atlas however had a new type of operating system – a multi-tasking, multi-user system known as the Supervisor – developed by David Howarth of Ferranti. It was said at the time that "*The Supervisor is the most ambitious attempt ever made to control automatically the flow of work through a computer… it will influence the future design of all computers.*"

Jobs were submitted to Atlas together with the user's Operation Request Card which indicated what resources were required for input (punched cards, paper tape, magnetic tape), for output (additionally line printer, graphical output), which compiler was to be used (including HARTRAN, Extended Mercury Autocode (EMA), or Algol), estimated compute time (in hours, minutes and/or seconds), and program size (in blocks of 512-words of store). The Supervisor was then able to schedule jobs in an intelligent way to group together programs requiring the same compiler, for example, or to avoid too many tape-bound programs running at once. The Supervisor was also able to terminate programs which had exceeded their allocated time, possibly because they were stuck in an infinite loop.

The Supervisor used a system of I/O wells and One-Level Store in the automation of the transfer of information between a relatively large amount of secondary memory on drum, and a relatively small amount of primary core memory in the computer. This concept is now known as Virtual Memory and is seen today in practically all modern computers.

Software

By 1969, compilers for more than a dozen low- and high-level programming languages were available to users. Lower-level languages included one based on Mercury Autocode called Extended Mercury Autocode (EMA), and Atlas Basic Language (ABL), a symbolic input language close to machine language where each ABL instruction corresponds to one machine instruction, and each part of an ABL instruction to each part of a machine instruction.

Higher-level languages included a version of FORTRAN, and Atlas Autocode (AA) which was an ALGOL-like language developed by Tony Brooker et al at the University of Manchester.

Even before Atlas had been delivered, it was clear that a FORTRAN compiler would be required because users at Harwell and Rutherford Laboratory had been working on the IBM computers at Aldermaston and Risley and had built-up a large number of FORTRAN programs. To address this, a team led by Ian Pyle at Harwell wrote Harwell FORTRAN (HARTRAN), a compiler and loading system based on FORTRAN II which was to be made available as soon as the machine arrived.

Differences in dialects across local installations of FORTRAN could be overcome simply by re-punching some cards. However, a small but significant number of Atlas users were from universities which taught ALGOL, and differences in ALGOL dialects across different universities were far more problematic.

To overcome this, an ALGOL pre-processor was written by Bob Hopgood and Alex Bell which eventually handled 15 different dialects of machines (Atlas, Elliott 803 and KDF9 inter alia) and humans (English, French and Danish).

```
    R1
    324    0    0    A1      set am' = 0
    121    7    0    1023    set b7 = 1535-512
2)  356    0    7    512     store, modified
    203    127  7    A2      count, jump to A2
    121    127  0    A3      exit to A3, not yet set
1)  +0
```

ABL routine (R1) to clear store locations to floating-point zero for working space and then exit to some as yet unknown address

Atlas shut-down

Atlas was finally shut-down with some ceremony on Friday 30th March 1973. The first test program had been to print "It works and about time too;" the final programme was to print "It worked… but now it's had its time too."

Over ten years of service it had processed 836,000 jobs, run for 44,500 hours with a 97% up-time (although Operators say that it felt considerably less!), read 300,000,000 punched cards and 4,000,000,000 characters from paper tape, produced 800,000,000 lines of line-printer output, punched 17,000,000 cards, and supported 2300 university projects.


Mounting an Ampex tape. An image of the Engineer's console downstairs is shown on the monitor.

Atlas Computer Laboratory main reception, 1965.

The Atlas Computer Laboratory building

When it was constructed between 1962 and 1964, the Atlas Computer Laboratory was one of the first purpose-built computing facilities in the country. Although somewhat unprepossessing from the outside, the interior was neat and tasteful, designed to meet the demands of the work and to provide a pleasant environment for the people working there. In the early 1960s, offices were "ponderous Victorian articles which encumber other Government establishments," but Jack Howlett broke free from this tradition to create a more European feel; even the desks were of Scandinavian design (made by the Birmingham Aston Cabinet Company).

In 1964, "Orbit" (the journal of the Rutherford High Energy Laboratory) reported:

There are half size offices called "cells" which house short term visitors and "think rooms" which are equivalent to library "quiet rooms" elsewhere. Perhaps the Atlas inmates think noisily. … The Computer Room itself is a science-fiction writer's dream-world of machines taking over man. Tapes wheel about on the 18 tape decks, results chatter out of machines wherever they will, seemingly completely independent of human control. Next door is the Card and Tape Store where the names on the data files really bring home the wide range and interest of the work the computer is handing. From frightening esoteric mathematical exercises like "Multivariate Analysis" we go via "Bubble Chamber (Geometry)" to "Children in Care," "Manager's Diaries," and "Animal Feeding Trials".

Atlas Computer Laboratory entrance, 1965.

Jack Howlett's office.

Atlas Reception, 1969.

The building was extended in 1966 to include a second office block and a library cantilevered above the main entrance. (The heavier journals were housed on the inner side of the room just in case!) It was extended a second time in 1970 to include a third office block, a second computer block for the ICL 1906A, the Atlas Colloquium lecture theatre, and a fish tank in the new Reception Area.

The Atlas Computer Laboratory was run by NIRNS, and located in the Parish of Chilton in Berkshire (now Oxfordshire because the boundaries have changed). The site was within easy reach of both of its main user-groups – scientists at the Rutherford High Energy Laboratory analysing data and performing simulations for the NIMROD linear accelerator, and scientists at AERE Harwell analysing data and performing simulations for experimental nuclear reactors.

The first phase of the building comprised 12,100 square feet over two floors, and was constructed by AEA Southern Works Organisation at an estimated cost of £278,000. Construction began in October 1962, and the interior was being fitted by February 1964.

The winter of 1962/63 was one of the worst in living memory. The River Thames froze so thickly that someone drove a car over it… and lived to tell the tale. Unsurprisingly, building construction was delayed by two months due to the atrocious weather.

The Atlas Computer Laboratory under construction, looking north-east towards AERE Harwell, February 1963. The Tandem Van der Graaf Generator is just visible against the skyline on the far right of the photo.

Dr Jack Howlett (1912-1999)

CBE, MA Oxon, PhD Manchester, MIEE, FSS, FBCS, FIMA

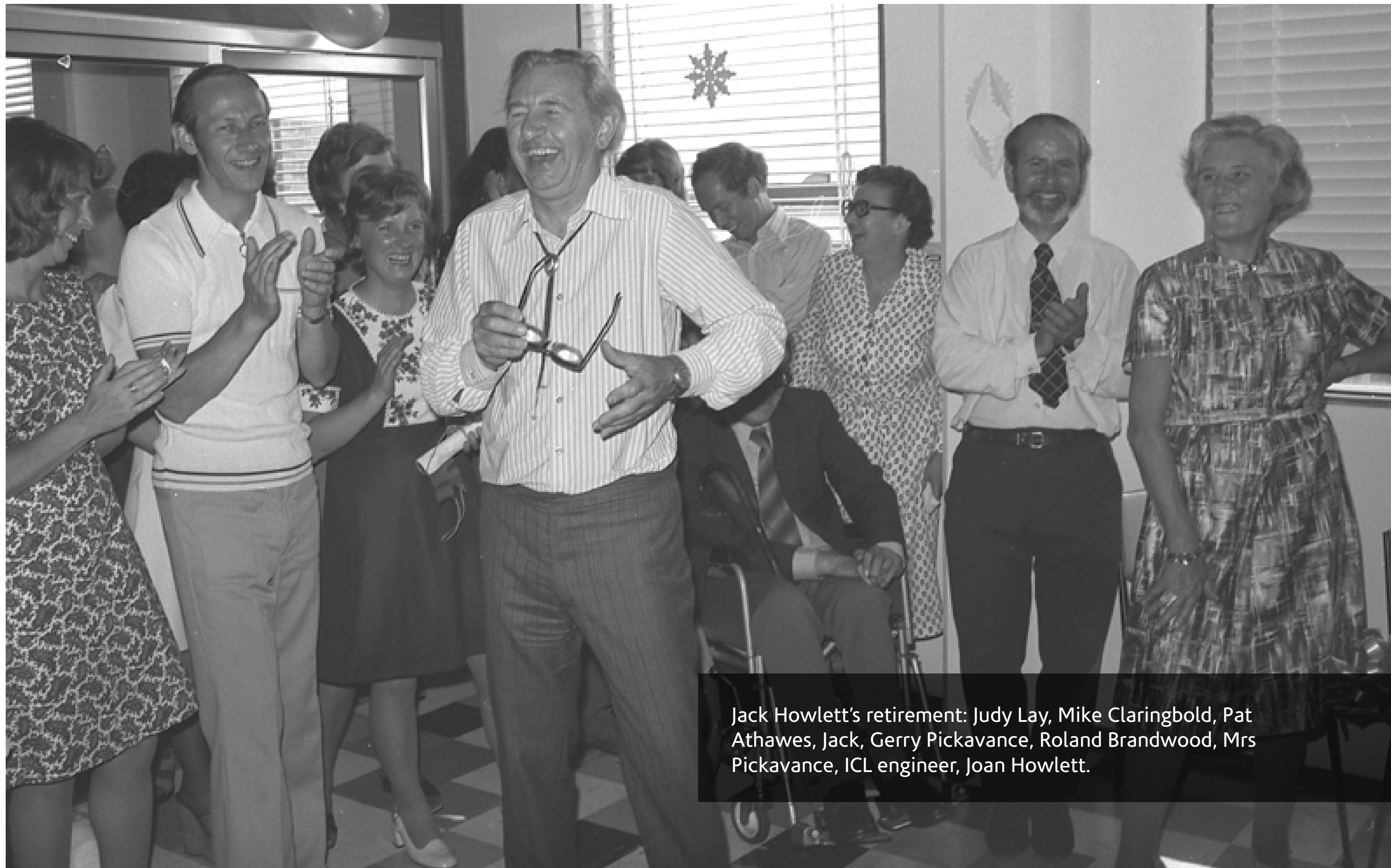
A mathematician who loved art, music, walking (especially in the Lake District), railways, trees, European culture, books and poetry, Jack Howlett helped boot the computer out of the mechanical era and into the electronic one.

Although his early career was at the LMS Railway Research Department at Derby, Jack worked during World War II on a mechanical Differential Analyser as part of a team of physicists led by Prof Douglas Hartree performing a non-linear parabolic partial differential equations on behalf of Rudolf Peierls who refused to divulge the purpose of this project, although clearly the need was serious. (This work was later found to apply to uranium isotope separation.) They also worked on an equally mysterious project for Klaus Fuchs (later identified as a Soviet spy), calculating the shock wave from a very intense spherical explosion.

In 1948 Jack became head of the Computing Section of the Theoretical Physics Division at AERE Harwell where he recognised that computers were increasingly important to all scientific research work, and encouraged his staff to use them. In 1963, he was appointed Director of the Atlas Computer Laboratory.

Jack was the sort of person who could get on with people, put them at their ease, and get the most out of them. He was a very practical sort of person who did not mind doing mundane jobs, although he took delight in finding better ways of doing them. He was also an exceptional physicist, and was awarded a CBE for his work in 1969.

When Rutherford Laboratory and the Atlas Computer Centre were merged in 1975, Jack retired; he died in May 1999. To have been a member of Jack's Atlas Computer Laboratory is still recognised as a privilege today.



Jack Howlett's retirement: Judy Lay, Mike Claringbold, Pat Athawes, Jack, Gerry Pickavance, Roland Brandwood, Mrs Pickavance, ICL engineer, Joan Howlett.

Atlas applications

Most jobs were submitted to Atlas as punched cards or tape and sent through the post; line-printer or graphical output was returned in the same way so job turn-around was about a week. A few years after Atlas was installed, a satellite Sigma 2 computer was added as a front-end processor.

This had direct access to the newly-purchased Data Products disk, and allowed users to edit interactively and submit their own jobs. Of the jobs submitted to Atlas, 40% were classified as chemistry, 20% physics, 17% maths and theory, 15% engineering; some applications are illustrated below.

Extensive use was made of the specialist peripherals at the Laboratory, particularly the Stromberg Carlson SC4020 microfilm recorder (later Stromberg Datagraphix SD4020 when the company changed hands), purchased for £70,000 in January 1967. At the heart of the SC4020 was a Charactron tube which directed an electron beam through a set of character stencils onto a phosphor-coated viewing screen which could then be filmed.

It was intended as a replacement for bulk printed output which was difficult and expensive to send by post. By improving the camera film registration problems to reduce jitter however, it was possible to control the device to draw "freehand" and produce animated research and educational films.

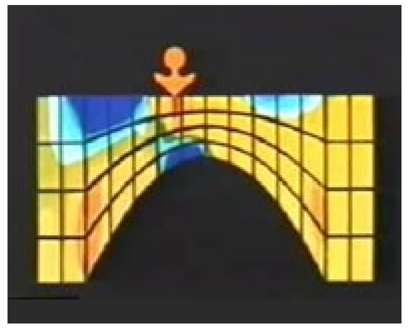
Non-Western fonts: Professor Susan Hockey used the SC4020 to develop software for non-Western characters, and produced a concordance of ancient scripts including Egyptian hieroglyphics, Arabic, Hebrew and Akkadian (ancient Mesopotamian).

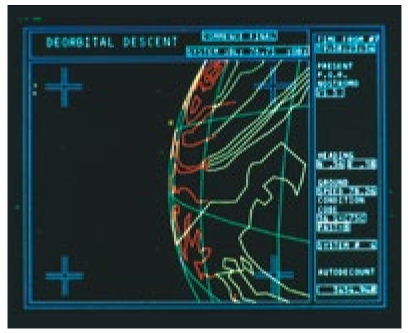
The Stromberg Carlson SC4020 microfilm recorder. On the right are magnetic tapes containing drawing instructions, and through the open cabinet door you can just make out the Charactron tube pointing upwards.

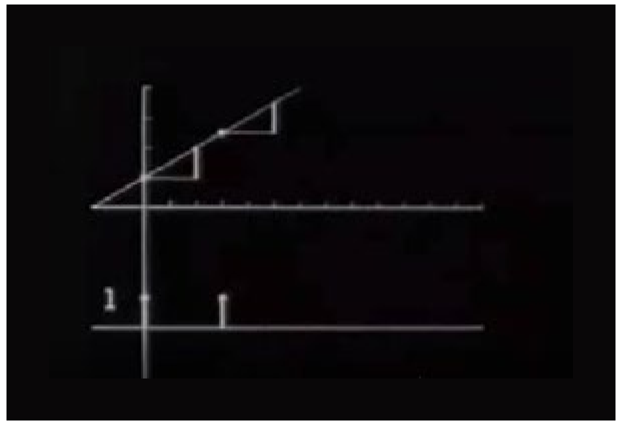
Animation for engineering and other applications: In October 1970, the Graphics Section under Bob Hopgood began work on graphics and computer animation. This work was highlighted in a Tomorrow's World programme entitled Computers and the animation industry, broadcast in September 1971.

Alan Kitching was an animator and designer from the Royal College of Art who, dismayed by the lack of tools available to animators, taught himself FORTRAN in order to develop ANTICS (the ANimated Technicolor Image Computer System). Together with Jean Crow at the Atlas Computer Laboratory, he used ANTICS to produce Finite Elements – one of the first computer-generated engineering animations in the world. It used finite element analysis techniques to illustrate the loading stresses of a bridge over the M6 which was under construction at the time. Finite Elements also had an "optical sound track" by Peter Hadingham, made by scratching on the sound area of the 35mm film. The film was an award-winning entry in the International Technical Films Competition held in Moscow, October 1976.

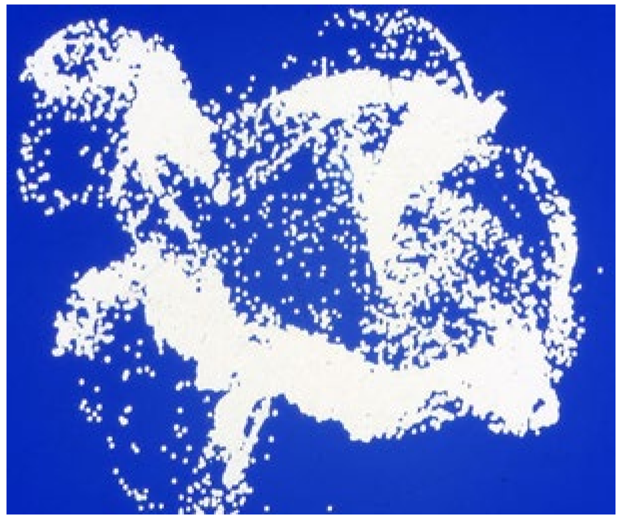
In 1979, Brian Wyvill used ANTICS to produce an uncredited sequence for the Ridley Scott film Alien which depicts the Nostromo's descent around the planet; his nickname – BLOB – is part of the read-out.



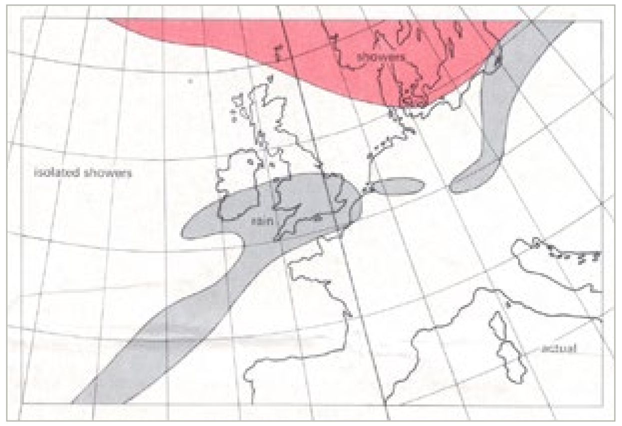




Explaining mathematical concepts: The BBC and Open University (OU) were interested in producing a series of animations for the new OU Mathematics Course. They wanted to illustrate mathematical concepts and show, for example, how polynomials change their shape as their coefficients vary, or how to explore a surface to find maxima and minima. Animations were produced using the GRaphic Output on ATlas with the Sc4020 (GROATS) software developed by Bob Hopgood. One of the people who worked on the OU project was Tony Pritchett, creator of The Flexipede – the first British computer-animated short film.



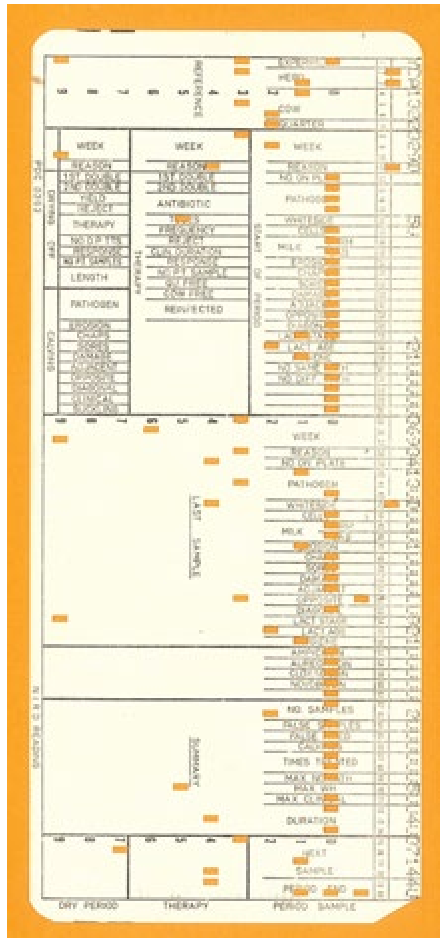
Particle simulations: Professor Roger Hockney of Reading University pioneered the use of particle simulations with the introduction of the Particle-In-Cell (PIC) method for modelling plasmas, galaxies, molecules and the universe. Using facilities at the Atlas Computer Laboratory he produced the film Galaxy Evolution – an animation which simulated over the course of a few minutes the evolution of galaxies of 50,000 stars.



Weather forecasting: In 1968, the Met Office used Atlas to develop a ten-level atmospheric model for forecasting rain which was more difficult than forecasting pressure patterns. The results were described as "very encouraging." Unfortunately, each forecast took 24 hours of computing to produce so the Met Office soon purchased their own dedicated computer (an IBM 360/195).

Data analysis: Decks of punched cards were ideal as an early form of database, and Atlas was used to analyse data from a variety of surveys. Animal feeding experiments were performed to investigate the comparative effects on growth of different diets; Richard Peto and Malcolm Pike at Oxford University studied the spread of the first human cancer virus across West Africa; and Elizabeth Gill characterised and plotted boreholes across the UK.

Games-playing programs: For some years, Atlas had been used to develop a number of games-playing programs, one of which became the Minimax Algorithm teSTER (MASTER). This program, by now running on the IBM 360/195, was a competitor in the first IFIPS World Computer Chess Championship in Stockholm, August 1974. (The people were in Stockholm, the computers stayed at home.) There were 13 participants, the Russian program Kaissa won the tournament, and MASTER was placed 8th.



Alex Bell, Peter Kent, John Birmingham and John Waldron waiting for the phone call with their opponent's next move.

Perhaps it is the rainbow's egg Or maybe the serpent's egg…

This iconic print was designed by Colin Emmett and Alan Kitching in August 1974 as an example of what could be achieved by the high-quality printers at the Atlas Computer Laboratory. It was produced using the ANimated Technicolor Image Computer System (ANTICS) animation system on the ICL 1906A computer. The scales of the snake's body are the months of the year in-betweening from one name to the next so that, for example, "January" transforms to "February" in 31 steps/days. The design was digitised on a DMAC digitiser, output to a Stromberg Datagraphix 4020 microfilm recorder, printed and then silk-screened onto gold paper.

Detail from "The rainbow's egg".

Although the prints are numbered as a series of 100, it is thought that only a dozen were ever produced. The Atlas Computer Laboratory retained print number one which is entitled "Perhaps it is the rainbow's egg;" number twelve is now in the V&A Museum and entitled "The serpent's egg."

What's in a console?

Many people have been involved in the restoration of the Atlas console; most of them were not even born when it was in use, only two of them have ever used it "for real." It has been a real labour of love, and at times, has required a considerable amount of detective work. It is surprising what you learn…

Weight: In the 1960s, equipment was built to last so the console is constructed from sheet steel. It took four men to slide it off the pallet and onto the workshop floor. Even after we discovered the castors built into the chassis, it takes a not inconsiderable effort to move so we estimate that it weighs about 150kg.

Electrical supply and wiring: The power supply is 28V, and the wiring is to Ministry Of Defence standard. The rubber sleeves around the wiring have started to deteriorate. The original power cable has collapsed because of this deterioration, and although most of the metallic parts survive, many have been compromised. A few of the thin wires connected to the bulbs have snapped; quite a few were deliberately severed to create a display for Jack Howlett's memorial celebration in 1999. We were told that the lights had been set up to display the octal 7004472 idling pattern, but when we first applied electrical power it was clear that this work was considerably more extensive than anticipated, and that quite a few "sneak circuits" had been created. For safety reasons therefore some circuits have been unplugged.

Buttons: Only the lowest row of buttons (RESET, ENGINEERS INTERRUPT…) have in/out positions; the others are simple indicator lights with connectors for four bulbs behind them. The buttons are of a design which was in common use at the time for control systems, and are believed to have been manufactured by Honeywell. We have made a few button covers to replace missing or badly damaged ones; they were deliberately coloured to match the (faded and yellowed) originals.

Bulbs: The bulbs are marked with a variety of stamps (mostly the first; see list below):

The modern equivalent is a Chicago Miniature T-1 ¾ Midget Flange Base CM387 with an expected 7000-hour life-time.

One of the Engineers on the London Atlas recalls:

We got through vast numbers of small indicator lamps shaped like small revolver bullets. They were used in all the Honeywell indicator lights and switches. We believed they were designed to fail because the American military used them and the military also had top priority for factory output. Each indicator should have had four bulbs but often we could only insert two and even resorted to moving bulbs around. Later, during the Vietnam War, they were even harder to obtain.

Extracting the bulbs from behind the button covers was a problem. An extraction tool which fitted the bulbs perfectly was reverse-engineered to gently push past the four retaining fingers and pull the bulb out. Then we discovered that the modern equivalent bulbs are slightly thinner, so we had to make a second extraction tool. Then we discovered that the original bulbs each differed slightly in diameter anyway.

Flip switches: These were originally thought to have been used in Spitfires, but this theory has now been disproved – the switches are too obtrusive and too easily altered to be safe in a confined space. (Rutherford and Atlas Laboratories and AERE Harwell were founded on the site of RAF Harwell during the war so this connection was attractive.) It is thought that the switches are actually of a type used in GPO telephone exchanges, although this has yet to be verified.

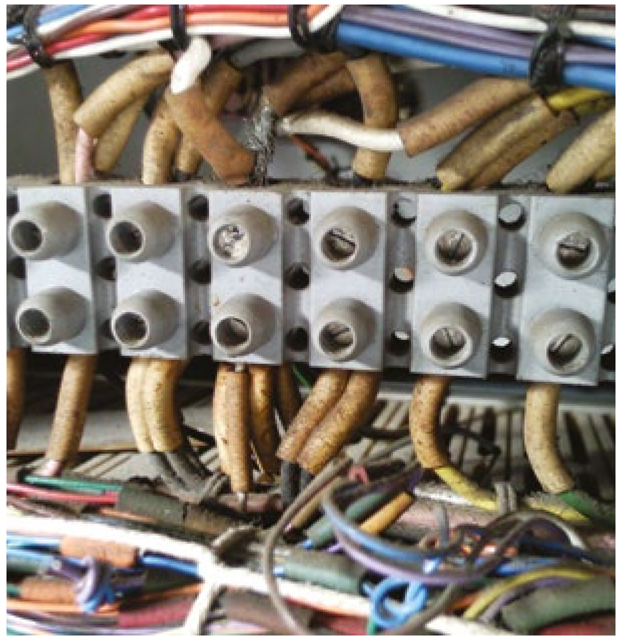
VTY 995-9118 28V .04A	ATLAS 28V – 04.5A L1338	ATLAS ENG 327	ATLAS 28V – 04A 005-9118

The Ferranti Atlas-1 console, November 2014.

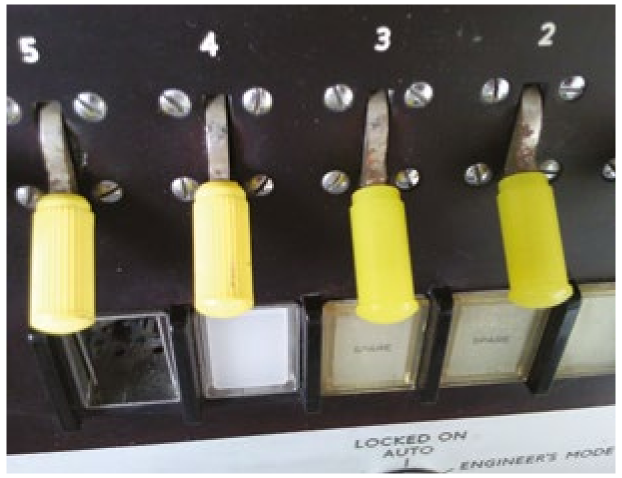
The plastic end caps were covered in black grease as though someone had repaired their car and then rearranged the caps without bothering to wash their hands first. A few of the plastic end caps were missing, damaged, or just crumbled away so replacement red and yellow versions were made. There is a single white end cap which was the most satisfying to clean, and which seems undamaged.

Behind the front face: Out of curiosity we removed the small, angled panel at the front of the console desk. There was nothing behind it apart from some 50-year-old grime and detritus.

1383: This label is the warehouse inventory reference number.



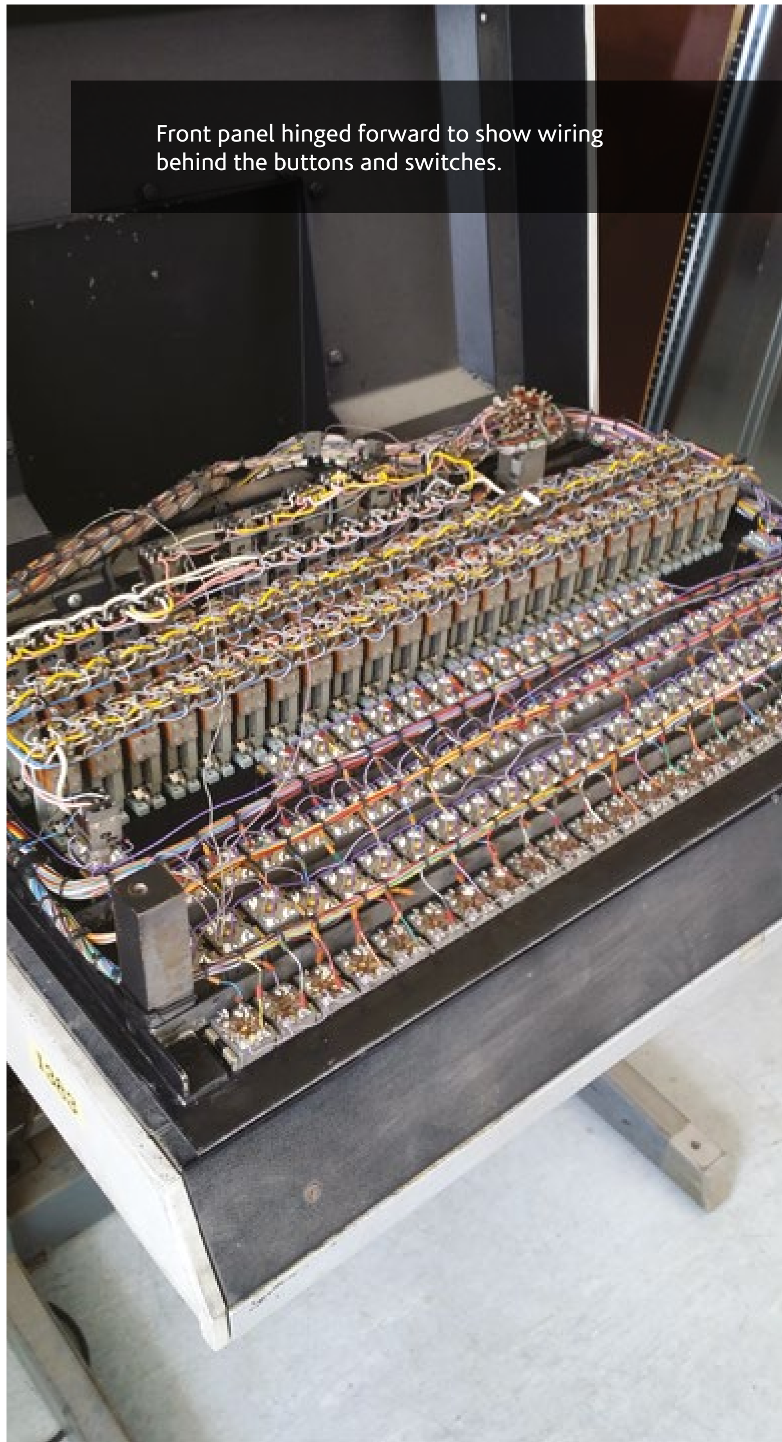
Deteriorated wiring.



Old and new flip-switch end-caps.

"PRE-PULSE" and "V/ADDRESS" volume knobs: The various units in the computer were synchronised using a 10 KCS oscillator signal, and a loudspeaker on the wall of the machine room enabled the Engineers to hear a steady "hooter" note derived from it. If the hooter stopped and the pre-pulse light on the console went out, you knew there was trouble. Several Operators recall hazing stories from their first week working at Atlas, and being sent to Stores to fetch a bucket of pre-pulses when the machine crashed again. Stores staff were very understanding: "So you're new then?"

The pre-pulse knob controlled the volume of sound, and the V/address knob the pitch so it was possible to programme Atlas to play tunes (when



Front panel hinged forward to show wiring behind the buttons and switches.

it wasn't processing user requests of course). Every time the machine obeyed an instruction that wrote a logical "1" to a particular V-store address, an audible blip could be heard from the console's loudspeaker. If the programmer timed the pulses with care, a steady tone could be heard. By varying the timing of one or more loops of instructions, a variety of tones could be produced which sounded like a sequence of musical notes played on a recorder. Operators recall that "Daisy Bell (Bicycle built for two)" was a favourite.

If the programmer was really good they could produce chords, and something resembling four-part harmony. There are rumours that Atlas could talk as well. (My thanks go to Simon Lavington for these details.)

Modern display: There was much debate over whether we should try to re-electrify the console or leave it alone. Because the wiring had already been modified in 1999 however we based our work on that; the rest is guess-work. None of the original 1960s wiring or circuits are used (we believe!) as they would now be unsafe; the 1999 wiring has been re-used however, with a new power supply and PLC to control the lights. We hope we have managed to bring the console back to life, albeit minimally.

"ATLAS" stamped bulb.

Back view of the console.

Console part-way through re-wiring. The covers have been removed from buttons we wanted lit so that new bulbs could be inserted, but it is not just these which are on!

The Atlas restoration team: Ashley, Victoria and Graham

Acknowledgements

Many people helped find the console, clean it up, maintain it, and understand it. They all deserve heartfelt thanks, but special mention must go to the following:

- Diana McCormack at the Science Museum for advice on cleaning the console;
- Graham Wiggins of the Electrical Engineering Group of the Central Laser Facility (CLF) who sorted-out the electrics and made the console come alive again;
- Staff and Apprentices in the CLF Workshop who help move and restore the console, especially Ashley Churchman who made the bulb extraction tools and flip switches, and Steve Hook and Henry Russell who made it all happen;
- Donna Wyatt in the CLF Target Fabrication Group who repaired the fixed store;
- Staff in the warehouse who carefully work around my bay of old computers;
- Prof Simon Lavington, Manchester Atlas alumni, and Dik Leatherdale, London Atlas alumni and editor of Resurrection, for their technical advice; and finally
- Prof Bob Hopgood, Chilton Atlas alumni, for his technical advice in person and via the magnificent Chilton Computing website.

Dr Victoria Marshall, June 2019

References

http://www.chilton-computing.org.uk/

Archive website created by Prof Bob Hopgood with information on the computers, people and work at the Atlas Computer Laboratory from the late 1950s to about 2000

http://curation.cs.manchester.ac.uk/atlas/elearn.cs.man.ac.uk/_atlas/

Archive website created by Prof Simon Lavington with information on all of the Atlas computers, especially those at Manchester

https://www.tnmoc.org/

Website for The National Museum of Computing (TNMOC) at Bletchley Park near Milton Keynes; Media Relations contact Dr Stephen Fleming

http://www.computerconservationsociety.org/resurrection.htm

Resurrection, the magazine of the British Computer Society (BCS) Computer Conservation Society (CCS) with articles on computer history and related topics, especially computers at TNMOC; edited by Dik Leatherdale

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Designed and printed by RCUK's internal service provider
2019 Second edition