

# Anecdotes of an Atlas maintenance engineer.

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*My early years on Atlas were the most enjoyable and exciting of my career. I was learning all the time and I have since realised that discovering new facts is my favourite pastime.*

*I once calculated that at least 30% of my time in the computer industry was spent in "self-training" or just in "learning". I later found that accountants will allocate a cost-code to "being trained" but refuse to accept "learning" to be a legitimate occupation!*

**Warning:** – *I am now in my seventies and my memory is not as good as it once was. The following are memories from half a century ago so the only guarantee I give is that there will be errors.*

## **My background**

### **School – King Edward VI Grammar School for boys, Camp Hill, Birmingham**

I passed Maths, Physics & Chemistry at A Level ; and the latter two at S Level. I stayed on an extra year to improve my Maths score so as to get into my preferred University, Manchester.

I have since realised that I would now be described as mildly dyslexic. At the time I was just yelled at to read and write faster and told that 2 out of 20 for spelling was not acceptable. I don't think that I have ever finished an exam in my life. I have always run out of time. Despite this, I obtained the best results in my year group at school.

### **BSc (Hons) Physics**

I studied Physics at the University of Manchester, starting in 1959 in a year with an intake of 100. About 50 of us gained Honours degrees, 5 being Firsts.

In the third year I opted to specialise in electronics and so studied alongside the Electronic Engineers in the building housing the Manchester University Mercury computer and the developing Atlas computer. Some of our lecturers were designing Atlas and its software at the time, e.g. Tom Kilburn, Dai Edwards and Frank Sumner.

Dave Aspinall (Atlas Magnetic Tape) supervised our lab practicals. It was here that I learned "Fault Finding" techniques. We were presented with a simple task such as build a (thermionic valve) Miller Integrator, describe and explain its operation, record the voltage levels and draw the waveforms obtained. We picked a valve (an EF50 from the Ferranti Mark 1 computer) from cardboard box "X" and had to stick with this valve whether it worked or not. We soon realised that none of the valves worked properly so the exercise was actually to diagnose the fault, explain what was wrong and finally add our calculations of what should have been the results had the valve worked properly. There could be no cheating or copying other peoples work because no two valves had the same fault on them and after use they were discarded into box "Y".

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I was mediocre at maths but excelled at project work. I liked the digital electronics and determined to work in computers after graduating.

### Job Interview at Ferranti West Gorton

My job interview at Ferranti was non-standard. Another graduate and I were left to kick our heels for an hour before a flustered engineer rushed in saying that our interviewer could not be found. He asked where we had come from as he had not been given any information by the personnel department. On being told "Manchester University" his demeanour changed from flustered to relieved and he just said that that would be alright then and proceeded to show us round the factory.

### No National Service

I later found that I was unusual in the workforce because I had missed National Service by three months. Most other engineers had either radar or missile experience.

## My experience of London University's Atlas

### Training

#### Tutorial Trainee

I joined Ferranti Ltd., West Gorton, in August 1962 as Tutorial Trainee. Training was to last 9 months during which time I would spend a considerable time in the training school on a computer design of their choosing.

#### Mercury

I spent a month training on Mercury as there were no Atlas drawings to work from. Mercury was a serial valve machine and Atlas a parallel transistorised machine so there was no similarity at all.

#### Atlas diagrams

Atlas "Overall Diagrams" and detailed "Logic Diagrams" started to appear but their issue was random and they could not be linked together. The "tutor" had many other jobs and it very soon became a self-training exercise within our small group (of three, I think). One would study a diagram then try to explain it to the others. We then argued until we came to an agreement. Everyone was working flat out so there was nobody available to confirm or correct our deductions.

#### Logic Symbols

Ferranti had its own logic symbols. The American line-printers used "shield" symbols which are now the ISO ones. Some of the logic for other peripherals used the supposed British Standard "kite" symbols which we all hated. The core stores and, other logic designed by Plessey, used "Plessey" symbols. I soon became multilingual!

#### Destined for London

It was soon agreed that single engineers would go to London while married engineers would go to Harwell where the male/female ratio was reputed to be 4/1. I had said that I

did not want to work in London as one reason to work for Ferranti but as a single person I was sensibly put on the London Atlas (and later married a Londoner).

### **Commissioning floor – West Gorton**

#### **Commissioning units from trollies**

In May 1963 I moved onto the factory commissioning floor, aiding the commissioning of units of Atlas as they were placed in position and learning from the commissioning engineers. All units were initially exercised from switches and lights on trollies, each of which also held a Tektronix oscilloscope. Each trolley had an isolating transformer and I think ran off 24volts. Each had a socket for a soldering iron.

#### **Soot and grime**

Atlas units were gradually linked together to build an extremely unreliable system. One third of the faults were “out & in” faults where removing the PCB, wiping the contacts & re-inserting it cleared the fault. Some dirt was fine grit that heat-cycled under the single contact edge fingers while other dirt was the tarry black smuts that got everywhere. In places the soot was nearly 1mm thick. (Harwell had better PCB sockets with 2 contact points per finger and so was very much more reliable.)

The West Gorton factory was later fitted with a false ceiling to try to cut the dirt but the factory’s origin as a place to build steam railway locomotives meant that soot was encrusted everywhere.

#### **Plessey dry-joints**

Every single PCB from the Plessey-built core-store had to be taken out and rebuilt; the resistors just pulled off the boards because of dry-joints in the soldering. We all took about two weeks to remove the resistors, then clean and tin the resistor leads before re-soldering them onto the board.

#### **Night work – banned from clocking in**

As the Atlas improved and the various main units were connected together it got to the point where the maintenance engineers from London decided to work four 10-hour nights to self-train while the commissioning engineers worked days. Several of the maintenance engineers were ex-Mercury and living in London and so resented being away from home all week. Nobody else was working nights in the factory other than one security man. I was then the only engineer clocking-in but was BANNED when my record caused the payroll system to believe that I worked from 8am to 10pm Tuesday to Thursday and then continuously from 8am Friday to 10pm Monday.

#### **Little green men running along**

We had our own language to describe the processes going on in logic circuits. I still think that it is far better than any descriptive language that I have come across more recently. Data was steered from buffers, along highways and cables to end up strobed onto another buffer of flip-flops. This was obvious and hardly needed to be described. Control logic was a different matter, especially as the computer was asynchronous and used a prepulse wandering round and round to control actions and timing.

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The controlling pulse was called a “little green man” (from the days of green phosphor on oscilloscope screens). Our little green man was a 100 nanosecond wide positive going pulse. He ran through the logic and was sometimes upside-down or standing on his head. At an AND gate he either found the door open or bumped into it and disappeared. He frequently came to a long-tailed-pair and split into himself and his upside-down brother. OR gates were either where paths merged or acted as AND gates for upside-down men when the upside-down doors were open.

We would use the two oscilloscope leads alternately and so it was easy to see the little green man had run from one point to the next. Sometimes the little green man had to be reshaped at a 100 nanosecond delay. Sometimes he had to wait in a 300 nanosecond delay before running on.

### Move to Gordon Square, London

#### Gordon Square, London

Atlas was moved to London in September 1963. In those days the Regency-style terraced houses of Gordon Square enclosed a private fenced park and only the secretary to the university Head of Department had a key. Now it is an open park. Across the square is the back of University College.

#### Delivery

On the delivery day a group comprising commissioning engineers, maintenance engineers and fitters from West Gorton assembled in Gordon Square on a bright summer's morning. The nearby parking meters all had their red “No Parking” covers on and there was a buzz of excitement. At about 7:30 a.m. the large sectioned crane arrived with the jib extensions on a separate lorry. The crane driver and his mate started to bolt together the long jib. Soon afterwards the driver got out of the cab of a lorry parked further along the road. The lorry was just a flat truck with a tarpaulin tied down over its load. We should have noticed earlier that it was from a company in Oldham, Lancashire.

The driver came up to us and asked if this was the right place for London University. He must have arrived at least an hour early. He did not seem to know what he had on the lorry so we explained that he had half of what the media called a “Giant Electronic Brain”. He then became interested and speculated whether his load was as valuable as a load of whiskey. He told us whiskey could be as much as £40,000 per load. We told him he had beaten his own record and to guess a higher sum. “£50,000?” – “No, higher”. “£75,000?” – “No, higher”. “Not £100,000?” By now the driver looked a bit worried. We put him out of his misery and told him the insurance value of his load was £1½ million. He nearly fainted, probably reliving his pre-speed-limit journey at a time when the M1 motorway had only reached Rugby.

The second lorry with the Tape Co-ordinator and peripheral electronics arrived later.

#### Switch Unit upset

Unloading was eventful. The crane driver had to get canvas covered units, still on their castored cradles, onto the narrow top step of No.44 Gordon Square. For the larger units

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we then had to push them partly through the doorway to get the back wheels onto the step.

Craning all went well at first. There were red painted wooden boards fastened around outside the tops of the units. The trollies under the units had eyebolts at the top of each corner. The crane had a stretcher with four horizontal arms, a central large eyebolt and short cables dangling from the end of each arm. These cables were shackled to the trolley eyebolts and gripped the top planks on the long sides of the longer units so that they could not tip.

Unfortunately the AC power filter and switch was only a single bay long and the cables to the trolley passed up beyond the unit to the stretcher without gripping the red planks at the top of the unit. The centre of gravity was now about half way up the unit and the centre of rotation was only about a foot (30cm today) from the bottom. Typical engineers, we discussed this and speculated whether the crane-mate would get a rope from the lorry or from the crane to lash the unit top to the dangling cables. To our horror the mate stood back and waved to say ready to lift. Doubly unfortunately one engineer yelled "Your centre of gravity is above your centre of rotation!" while some others of us yelled "Stop!" The mate yelled "My mate knows what he is doing, LIFT", and raised his arm. The switch landed neatly upside down in the road and was later found on inspection to be undamaged apart from a small crack by one of the many fixing bolts.

### **On-site commissioning**

#### **Jammed lift**

The power supplies had been installed prior to my arrival. The motor-alternator sets had had to be got down into the basement so a car lift had been installed. The lift was specified to be capable of handling a 5 ton armoured Rolls Royce car so should have easily coped with the 3½ ton sets. It did not. A set was loaded, the descent started and a juddering halt achieved. The centrally positioned set had bowed the floor enough to jam the safety wedges against the four guides. I was told that the lift engineer who came to the rescue arrived with a large lump hammer, climbed up from the basement and knocked the wedges out over his head. He pointed out that a car had wheels at its corners, not in the middle.

#### **Long Commissioning on-site**

Commissioning continued on site for over 6 months. I believe that the last remaining commissioning engineer on-site only just saved his marriage. It was possibly March 64 when it lasted two cycles of self-test without failing. Self-test was at 5 minute intervals.

#### **Hot fuse**

One of the first unusual faults was that we had to keep increasing the voltage output of one of the minus 10.5 volt PSUs to get 10.5 volts at the computer. One day I squeezed round the back of part of the PSU and spotted solder drips on the floor under one of the 500 Amp fuses connecting the bus-bar of the unsmoothed minus 10.5 volt supply to the regulator unit and switches. The copper leaves of the fuse and the 3-inch copper bus-bar were both beginning to melt and the insulation had burnt back a good way. The system

was generating half a kilowatt at the joint because the high-tensile steel bolt was not tight enough.

### **The maintenance team**

The Maintenance team was initially an Engineer in-charge, a Second in-charge and three maintenance engineers. I was paid about £1,000 per year (pay was strictly by age and I was the youngest). We rapidly moved to working what is now called 24/7. Before this we saw an advert for new trainees with a starting salary of over £1,200 so I rang my manager's manager asking for one of these trainee positions. The result was that the payment by age was cancelled; I got a large rise and very soon became a Shift Leader with two trainees under me. By the time I left I was paid about £2,000 per year. When I left there was an Engineer-in-charge, (no Second in-charge, I think) and four shifts of a Shift Leader plus two maintenance engineers.

### **Arithmetic unit was voltage sensitive**

We had to borrow a "Sub-Standard" voltmeter to set up the minus 10.5v in the Arithmetic Unit to exactly 10.5v and re-adjust every few hours. This was in order to get the "Test Fails" test program to actually pass. Much later I traced the problem to a logically (but not electronically) impossible condition causing one more than the maximum permitted number of inputs to be connected to each of 48 bistables (or "flip-flops" as we called them). Occasionally one of them would flip (or flop) rather than remembering their correct state. I was allowed to re-design the flip-flops on the PCBs to eradicate the problem. This was my only PCB redesign.

### **PSU settling time**

Before this time, when we first had the computer switched on all week, I plotted the 20 or so voltage outputs against time during the week and discovered that the Lancashire Dynamo built PSUs took up to four days to settle after switch-on. They all had different time constants for their classic overshoot, undershoot then settle for a control system with feedback.

### **Reliability continually improved**

By the time I left Atlas in June 1967 the machine was only failing about once per day and very boring to maintain.

### **Upgrades**

We had three major upgrades and one minor one while I was present.

- The Core memory was increased from 16k words to 32k for about £½m. This upgrade also involved a complete replacement of the Core Co-ordinator.
- The second was the addition of two ½inch tape decks and their controller. Backwire colours were supposed to be random so as to aid tracing them through the rats-nest. The English language was proved to be ambiguous when we found the top "box" wired in random black, the next in random brown, then red etc. working through the colour code 0, 1, 2.....
- Another was the replacement of the magnetic drums with Bryant ones. These improved drums were slightly conical and rose on a governor mechanism to engage the individual flying heads when close to operating speed.

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- A high speed (25 x TV co-ax cable) link was developed in the basement back room. It linked to the Imperial College bubble chamber. It did not last long because a digger cut through the 25 cables during road-works in the Tottenham Court Road and it was never re-instated.

### Fires, air and water

#### Cooling water

We had four (I think) very noisy compressors in the basement. They were just inboard of the electricity sub-station transformer. Every now-and-then they lost Freon refrigerant and had to be topped up. They were used to cool the 4,000 gallon tank of chilled water in the same room down to 10 degrees Celsius. This water was fed to heat exchangers below the large fans in the cooling units at the end of each bay of the computer. The core stores had a fan at each end.

#### Fans & drain

The fans blew air down through the heat exchanger then the air blew up through and behind the electronics. Each heat exchanger had a drip tray under it with a hose pipe to the basement water sump. The water gathered in the sump well and two float switches controlled the pump used to empty the sump. I think the timer was set to 25 minutes and if the pump was still trying to drain the sump after this time the alarm bell rang. The only time the bell rang was after a new intake of staff. They did not know that we had a sump well, let alone what this bell was for.

#### Yoghurt store

The back of the "Core Co-ordinator" was where spare milk and Ski Yoghurts were kept because its door was just behind the engineers' chair at the Engineers' Console.

#### No air?

One day, soon after delivery, the Fixed Store tripped off with "Fan Fail". We opened up the fan end and were horrified. The flap detecting the airflow was so loaded with soot that it would not raise. We looked in other nooks and crannies and found some components so buried in oily soot that even their shape was indeterminate. We had brought our own smog from Manchester. [Aside – I once walked 4 miles to my digs in thick Manchester smog when I could just see my feet. I used my scarf over my mouth as a filter but the loose weave clogged up twice and I was on a third patch of scarf before I reached home, coughing & wheezing most of the way. Obviously there was no traffic to worry about, just a silence. Repeated washing has never removed all the black stain.]

#### Cable-loom fire and Winston Churchill

One night at about 2 a.m., there was a sizzling then a small bang and a beautiful plume of smoke rose from the back of the AC Power Supplies then mushroomed on the ceiling. All fell silent as the mains was tripped. Inspection showed that a loom of about 200 power wires had fused together from the middle. We all decided to abandon the computer and cross London to join the end of the queue at Westminster Hall to see the Lying-in-State of Sir Winston Churchill. We just got in at 5 a.m. with an hour to spare before final closure before his state funeral. All the wires were pink but of different gauges so the rebuild was slow.

### **Clothes drier, the motor-alternator room**

The basement compressor room and the adjacent motor-alternator room behind it were used as a short cut to the basement workshop and the main computer room. The motor-alternator room had the added advantage of being warm and having a blasting airflow so was used for drying clothing and also towels after a shower. Visitors could be met by drying bikinis if the girls had been swimming.

### **A waterfall and paddling engineers**

One day there was a violent thunder storm and torrential rain. An operator appeared in the workshop and reported a waterfall pouring out of the air-conditioning input and onto a 400Hz alternator. Everyone went to look at the spectacle and a sheet of something was eventually positioned to divert the water from splashing into the alternator cooling-fan intakes.

Next – look for the fault. It was probably five of us engineers who put on coats, took off our shoes and socks, rolled up our trousers and crawled out through a sash window into the 9 inch deep lake on the flat roof of the alternator room. We expected there to be a break in the wall round it but there was none. The large cowl over the air intake had its skirt in the water so water was being sucked in. There had to be a drain somewhere but the wind and torrential rain, plus dirty water, made it impossible for us to see our ankles, let alone our feet. We shuffled around like zombies feeling with our toes for a depression where a blocked drain might be. We covered the whole surface about twice – no drain. A large diameter lagged heating pipe came up through the roof and in desperation I explored round it with my numb toes. Eureka, a narrow gap all around the pipe and jammed with lagging. I pulled the lagging free to cheers from the watchers at the windows. By then we had a large audience enjoying our discomfort out in the freezing rain. At least we knew where to dry our outer garments but we were soaked to the skin.

### **Fire-extinguishers bite**

On another occasion an operator, emerging from the alternator room, asked if we engineers had noticed the smoke streaming from the top of the AC switch unit. Yes it smelt of an electrical fire and the plume of smoke went straight up and into the air exhaust vent, missing two smoke alarm detectors in the room. We shut the machine down then pulled out the knob on the telescopic lever of the main switch in order to be able to isolate everything from the raw mains electricity. We knew it could only be inductor insulation and/or the thick paxelin insulation mount that was on fire. The youngest engineer, Mike, was then volunteered to stand behind the unit with a CO<sub>2</sub> fire extinguisher at the ready while others of us used the T keys to open the back panel. As soon as more air got in the unit burst into flame. The CO<sub>2</sub> put it out but the hot copper inductors re-ignited it. Several extinguishers were used up. The large audience that had gathered to see the fire occasionally sent a runner to get another extinguisher.

We had told Mike to keep his hands away from the horn of the extinguishers or he would get frostbite. This he did but every now and then he complained of getting electric shocks – indeed we could see his back arch and his body twitch. We pointed out that he could see the mains switch lever was at off so he would not die. Then someone got a shock while handing another gas cylinder to him, we now really believed him. Static electricity was the culprit. We cruelly suggested that he stand nearer the fire and never lean back to touch the



earthed cable duct behind him. The young female operators thought he was a hero so afterwards he did get some sympathy. With a dead computer on our hands we then made a large ball out of scrap paper and sticky tape and had a fantastic game of blow-football up-and-down the ground floor computer room to use up some more extinguishers. This was thinking time. We altered the maintenance schedule to include yearly tightening of the high-tensile steel bolts of the terminals so as to compensate for the copper-creep of the cable ends.

It took 15 minutes before a smoke alarm went off and the fire was out before then. The alarm was in a completely different part of the building and set off by smoke re-inhaled at the main air conditioning air intake.

### **A spoilt holiday**

The next day we had a visitor. A senior electrical fitter was down from Manchester on holiday with his wife to visit London. He had left her shopping and popped in for a chat. He was brilliant. I don't think he left the site for the next 24 hours. He jury-rigged the mains wiring to by-pass the burnt out mains filter section and switches. He then set up just one configuration of one 400Hz set and one 50Hz + 400Hz set.

### **Melting iron**

All went well until a week or two later when the sleeving on the quarter-round red phase of the aluminium mains cable nicked itself on the sharp edge of the cable duct in the concrete floor. The armoured part of the cable had been too short to reach. It blew a deep notch in the steel cable duct but hardly damaged the aluminium at all. A hammer was used to reshape the mains cable, a few layers of red insulating tape applied and we were on the air again.

### **Switches at sea**

One of the (two-yearly, I think) maintenance tasks was to change the transformer oil in the tanks which held the DC switch contacts, ten per tank. The switches operated on a snail cam which slowly wound the contacts in in the correct order and clunked off with a bang aided by powerful springs. We used about an oil-drum full each time. All went well and as we were working three shifts at that time it was not until the next Friday that we switched off again. We pressed the OFF button, heard the motor drive the gang of three main switches, heard the clunk. I went and switched the AC off and was just about to go to switch the raw mains input off when I noticed that the console lights were still lit – on a silent, supposedly switched-off machine. The lights were running on the alkaline batteries in the battery room. One whole tank of switches had not sprung out. We stripped the switch down and found all the contacts corroded together. We later found that a dinghy sailor had “borrowed” our permanently-primed oil pump from the store to use as a bilge pump at sea. We had filled the first switch tank with sea water.

### **Unreliable magnetic drums**

Temperature had a great effect on the Ferranti magnetic drums (pre-discs). The drums were made from two narrower drums mounted side-by-side on the same shaft. Each cylinder section was full width at the rim and tapered to much narrower at the shaft near the centre. The heads were in banks (of 16 heads per bank?) and each bank was attached to an outer frame. The heads were supposed to be adjusted to be 0.9 thousandth of an

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inch above the drum surface. Each end of the head bank had a tiny hole in it and one first connected an air hose then adjusted each end to give a back pressure at the hole equivalent to 0.9 thousandth of an inch. It all sounds simple until you think about it. The drum must be up to speed when adjustments are made. The periphery of the spinning cylinder expanded out under centrifugal force by 2 thou, the less stiff edges even more so. The friction with the air heated both drum and case but at different rates; another 2 thou of expansion. There was thus no margin for error. Worse still, if switched off, the case cooled and contracted while keeping the drum warm inside. Many drums were written off before a rule was made that: - 1) A drum may only be re-started within 15 minutes of switch-off. 2) Beyond 15 minutes the drum must stay inactive for a minimum of 6 hours to allow the inner cylinder to cool down.

### Perforated armpits

The Tektronix oscilloscopes on the trolleys had a very handy horizontal link at the back which was ideal for hanging a hot soldering iron on. The sloping tops of the oscilloscopes were also ideal for resting ones elbow on while chatting. The combination was ideal for burning a neat round hole through ones clothes and then burning ones armpit.

### More melted metal

The low voltages present in a transistorised machine don't shock when touched. The power is still there and the over-current trips are set high. One engineer had a deep notch in his gold wedding ring. On another occasion an unreliable engineer switched off the wrong bay of electronics before I tried re-soldering a dry-joint on a bus-bar. The soldering iron tip got welded to the bus-bar. That engineer was the only one we had to get rid of.

## Maintenance

### Morning maintenance

Two hours each morning were devoted to routine maintenance. Much of this time was devoted to "Swinging the margins". A 7.5 volt line could be switched from fixed to variable and the aim was to get a wide working voltage range on each half-box of 24 circuit boards.

### Core Stores

On the core stores we had two problems caused by components aging.

- The differential amplifiers of the "Read Amps" drifted. The amplifier board had to be put on an extender board, the store exercised with a store test program and a tiny circular ceramic pot (potentiometer) had to be adjusted to give the best shaped output waveform for each of the circuits. [See Spares also].
- Another problem was that the input potential divider on Plessey logic boards was implemented with a zener diode and a resistor. Theoretically this should have given a larger voltage swing at the transistor base input. In practice many of the zener diodes had a "knee" starting just above 2 mA and so were worse than resistors. They also changed their characteristic with age. In order to get 5% tolerance on the zeners we had 10% tolerance ones with blue spots or yellow spots painted on them to indicate above or below the median. I got so fed up with the zeners that I made a tester giving 1.5 mA and threw away all the spares that were on their "knees" at this current.

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- A third problem was that the “Inhibit Drivers” drove 450mA. Current systems don’t like high resistance contacts.

### **Tape path adjustment**

The 1 inch Ampex tape decks had to be set up frequently. So frequently in fact that many of us could “see” a parallel 10 thousandth of an inch pinch roller gap and did not bother to stop the deck and use a feeler gauge to measure it. Likewise, tape skew was adjusted on-the-fly using a spanner in one hand and a screwdriver in the other and “light hands” so that one could ignore the movement of the pinch actuator.

### **Tighten the bolts**

Yearly, after the AC switch unit fire, we tightened up all the power cable connections. Most of the heavy current supplies of filtered DC were taken to units using 1500 strand welding cables while small currents used 750 strand cables.

### **Top up the batteries**

Another yearly task was cleaning the terminals then topping up the sodium hydroxide in the batteries in the battery room. The batteries were to stop voltage lines crossing during switch-off.

### **Check the electrolytic capacitors**

About monthly, we checked the electrolytic capacitors of the DC filters for leakage of electrolyte and bulging rubber seals. Occasionally we found one totally extruded from its can.

### **Motor-alternator maintenance**

The motors and linked alternators used for removing the glitches from the mains all had to be greased regularly and their brushes checked. The small motor, belt and alternator feeding the magnetic drums needed the belt tension checking. When we eventually changed the V belt we found that the new one was of slightly different width, rode higher in the pulley grooves and resulted in the wrong electrical frequency at the output. We had to do hard sums then get a workshop to skim one of the pulleys to get the frequency right.

### **Check the mag tapes**

Magnetic tapes were pre-addressed into blocks. The front ends of the tapes wore out and failed long before the rest so we cut the ends off and re-addressed the remaining part. The pinch rollers were supposed to clamp down on the tape in the inter-block gap. A re-addressed tape could easily have old pinch roller landing points in the middle of a block if we had not cut enough off. Thus the magnetic oxide could be worn in the middle of a block and lead to bit drop-out. Occasionally we could recover a tape by monitoring the amplifier output on an oscilloscope and adjusting the amplifier gain using its adjustment potentiometer at the board edge.

### **Clean the tape decks**

Tape decks built up oxide film on the head, the pinch rollers and the tape guide posts. The brown oxide welded itself together and could rapidly form wedges or needles. The decks had to be cleaned frequently and carefully. At first we used isopropyl alcohol which was

very effective. This was then declared carcinogenic and we had to use a vastly inferior cleaning agent.

### Repair

#### Board test & repair

We had exercisers with switches and lights which enabled us to check out boards and repair them on-site. Other boards were sent for factory repair. We usually checked transistors and diodes with a Taylor multimeter rather than going to the bother of powering them up. I seem to remember that the AVO multimeter had a 22 volt internal battery and occasionally blew up the transistors, whereas the Taylor meter had an 18 volt internal battery and was OK.

#### Out-in faults

About one third of faults were “out-in” faults where pulling the board out cleaned the gold contacts and all was OK when the board was re-inserted. In a dataflow this was a 10 minute repair if the failing bit position was known.

#### The Purple Plague

After two years of use the Tape Co-ordinator got the “purple plague” from cold hard gold combined with soft solder. The resulting purple inter-metallic compound is brittle and gave rise to many “dry joints”. The Tape Co-ordinator was a clocked machine and, uniquely, the backplanes (“boxes”) holding the board sockets had printed wiring on them. We had to re-solder every socket pin where it met a printed-circuit pad.

#### Soldering behind the boxes

Repair and modification of the wiring behind the “boxes” could be difficult. Wires were of random colours, soldered to the socket pins and taken directly to their destination. The wires touched or obscured many other pins and some were almost as tight as piano wires. Engineers needed patience in using a crochet hook first to reveal a pin then secondly a steady hand with the soldering iron to avoid scorching or melting the PVC wire insulation. Later we had some wire with polycarbonate sleeving but that was hard to strip.

#### Burn, shock or both

The servo systems in the Ampex TM2 tape decks slowly deteriorated so that the tape reel-motors could not drive hard enough to control a full reel of 1 inch tape correctly. There was one main thyrotron valve with a top cap anode and four other thyrotrons, all mounted horizontally in an aluminium box. With the deck working, one unscrewed the surrounding aluminium box, peered in and any “soft” thyrotron would have a pink gas glow when fired instead of blue. These valves were big and hot and had almost welded themselves into their valve bases. First one switched off at the deck, the switch being on the lid of the aluminium box. Then one got a cloth, knelt down and with arm fully extended, grabbed the valve with the cloth and levered it round a bit before pulling it horizontally. If it released it did so suddenly. One then had an almost red hot glass valve in one’s hand and the back of one’s wrist neatly bridging the unsleeved live studs of the main electricity switch under the lid of the aluminium box. I still have a feint circular scar on the back of my wrist. Insulating tape just melted off the switch studs so we gave up looking for a solution. Nobody died.

### .....Closely followed by a capacitor can

A fellow engineer told me that he was trying to find a fault in the power supply at the back of a tape deck when some sixth sense told him to duck. Others reported that he took his head out of the deck then he both flattened himself to the floor and crawled backwards at the same time. He was closely followed by the yellow can of an exploding large electrolytic capacitor.

### Was the mains 10% low in a Brown-out?

During one winter we had frequent "Brown-outs" when the power stations had too little fuel to supply the demand. One evening the Atlas "tripped off" on "10% low input" mains. We checked a few times and were sure that the mains input voltage was now below legal specification. I rang London Electricity Board and asked for more power because the £2.5 million machine was now dead. They sent two senior crew who checked our input with their official meter and declared we were only 9.9% low, not 10% but shrouded their meter from view. Despite this they offered to give us another 1% and said they had a crew on the taps at our local electricity sub-station. I was rung from the control centre. "Have you got the 1% yet?" I was asked. I replied no, not yet. "We'll give it another tap." I was told. I was rung again and I reported still no change. Five minutes later I got a call to apologise that they had altered the wrong sub-station taps but a crew was on its way to the correct sub-station. Ten minutes later we were given 5% back which was probably better than anywhere else in London at the time. Honour was satisfied and I formally reported that their meter had shown that LEB were not out of spec. so no useless paperwork was needed.

### Board removal an insertion

Every plug-in board had a thin flexible paxolin backing sheet to insulate its printed circuit back. The large OC170 transistors were laid on their sides but were fat enough to catch on the front edge of the adjacent sheet as one attempted to insert a board. These cans were also earthed. One had to part insert a second backing sheet with the left hand in order to allow the right hand to push in the board. However, the backing of the board being inserted might in-turn catch on the transistors on the board to the right so sometimes two sheets were required, one for each side.

### 16 sets of side-cutters worn out

The OC170 RF transistors had a fourth electrode, a screen earth to earth the can. This lead was next to and in-line with the collector lead of the transistor. After a year or so we started to get strange faults where the collector of a transistor became earthed but then recovered. We then learned that tin can exist in two phases, alpha-tin and beta-tin. Alpha-tin exists when very pure tin is cooled and it is brittle, dull and a powdery grey. It can grow long grey crystal whiskers. Beta-tin is the normal shiny metal. The whiskers grew long enough to short out between the two electrodes then fuse open circuit as the current flowed. The cure was to abandon the screening and cut off every screen lead on every board in the machine. It took a long time and required accuracy in not damaging the adjacent collector lead. Only the tip of side-cutters could be used. 16 pairs of side-cutters were rendered useless by wearing away notches just inboard of their tips.

### Spares

#### £100k spares on site

We had about £100k of spares on site. PCBs (just called “boards”) were racked in one steel cupboard while another had drawers for small components like transistors and capacitors. Larger items were kept in a store room beside the bottom of the lift. About another £100k of stores was kept centrally for all Atlases.

#### Sleeping priority

The top of one rack in the store cupboard for spares was kept empty because one of the staff kept his sleeping bag there and slept there when he had missed the last train home.

#### Buy the pots back

The ceramic pots on the Plessey read-amps were fragile, their legs snapped off. We held a large stock of them so as to not run out. Eventually we ran low and ordered many more from Plessey. They had stopped making them and had sold off all their backing spares stock after a year because “obviously nobody wanted them”. Fortunately they had been sold cheaply to an electronics shop in the Tottenham Court Road, a mere 10 minutes’ walk away from Gordon Square. Hagglng took place.

#### Bulb shortage

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.]

#### Fault finding

##### Three way swap in the core stores

The data flow of the core-stores was made up from the read-amp, the data register and the “inhibit driver” as well as the core itself. The core planes were in a tank of transformer oil to dissipate heat and so were called “tanks”. If there was an intermittent “parity fail” indicating an incorrect read, we might find the failing bit from software or by using a store test. We would then do a “three way swap” and record it in the Engineers’ Log. One board was swapped with its left neighbour, another with its right neighbour, the third was not moved. The next failure would indicate which board was at fault by which bit failed.

##### Late bit

One core in one core-plane in one tank was 60 nanoseconds late to give a read pulse. We had to describe it by the socket-pins to which it was connected. These pins were the ones which passed the X and Y write currents and the inhibit current. It may appear easy but Plessey numbered the pins one way, Ferranti numbered them a different way and the socket mouldings were different again. (It is impossible to read moulded numbers when plugs or sockets are buried in a machine.) We carefully gave all three descriptions to Plessey for repair to be on the safe side. I vaguely remember that the tank was returned

unrepaired twice. The first time I think Plessey reported that their tester showed that there was no fault.

### **We'll all go together**

Very occasionally the core stores filled in the only "zero" in a word with a "one" if all the other bits were "ones". I traced it to one of the "write-current" wires which ran parallel to a signal wire for over six inches. There were no more of these instances after the current wire had been re-routed well away from all the signal wires.

The same sort of thing, gained bits, occurred after some inverter logic boards (strobe drivers) had been beefed up with more powerful and faster switching transistors. The pulses then had beautifully sharp edges. The result was as if a good majority of bits voted one way the rest decided to make it unanimous. It was easy to slug them with a small value capacitor and then they no longer chatted among themselves.

### **"Lost prepulses"**

Most of Atlas was not a clocked machine, it was asynchronous. "Lost pre-pulses" in the control logic brought the computer to a halt because the next step never took place. The control address of the failing instruction was visible on the top row of lights on the Engineers' Console.

Finding a solid fault was a case of setting up the failing instruction on the handkeys and blasting prepulses in from the 100 kHz clock. The expected logic path was then "halved" and "quartered" repeatedly, in the usual way of fault-finding, until the failing circuit was found.

Finding intermittent faults took a long time because one had to examine the machine state when it stopped. A great number of output levels had to be checked and mentally compared with what they should have been. Eventually one worked out where the illogical step had taken place and thus what might have gone wrong. These faults typically took a minimum of two hours to diagnose and could take much longer.

### **The card punch takes a day off**

One day the card punch refused to work. It worked on self-test but not on-line. The problem lasted all day and had us baffled but the next day it worked so we forgot about it. About a year later the card punch again refused to work. I vaguely remembered that this had happened before and looked at the old Engineers' Log to see how we mended it. We hadn't – bother! Then I noticed that the date was identical. The card punch was taking the 11<sup>th</sup> of November off! The date was set on switches in the back of the Peripheral Co-ordinator. It was in BCD so read 0001 0001 0001 0001. I wish I could remember what was overloaded in the Peripheral Co-ordinator but it was certainly on the same circuit as the card punch.

### **Furry cards won't go**

Many of the cards we had to read were data sets used over and over again. Their edges got furry and fat so we deliberately compromised by setting a wide card-feed gap at the throat of the card path. Later London bought a stand-alone card interpreter to print the

data along the top of each card – much easier for the programmers. We set the gap to accept furry cards and all was well. One day we had some irate programmers. Their cards had not fed through the interpreter and, worse still; the feed knife had ruined the back edge of each card, damaging it so badly that each would have to be re-punched by hand. We found that an ICT Punched Card Engineer had been in and re-set the gap to the specification.

### **Do you like paper fans?**

One programmer had a data set of cards punched in binary. He tested his program on a small set and it worked. He then came in with several boxes of cards and started the job. A few inches of cards behaved perfectly. Then the disaster came. The weight of cards in the collecting hopper was too small to compress the spring sufficiently. The pile grew high enough to block the exit path for the read cards. The cards were being read beautifully and passed all the card-jam detectors along the card path. They then folded into cardboard fans and were fed into the bowels of the reader. Some were now oily fans. They were in binary so had not been, and could not have been, interpreted. A despairing researcher had to iron them out and hand-punch all the data again. A month or so later an operator stood at the hopper and frequently removed small packs into a box before the pile had a chance to build up.

### **It's always the lights on the lineprinter**

The Anelex lineprinters were remarkably reliable. Their hammers and hammer drivers failed occasionally and were pigs to adjust but that was to be expected. About once a year, a bulb would fail on the position detector that read the position of the print barrel. We learned not to bother looking at the digital logic if gobbledygook was printed, just replace a bulb. One day we found we had a power rail failure deep inside where we could hardly see. We got out the power supply diagrams for the very first time but could not make any sense of them. I then counted the relays in the printer and compared this number with those on the diagram. The printer won by three relays! We were in big trouble! The printers were a special batch and America had no record of them or their diagrams. One power rail was at a wrong voltage so I followed brown wires through other brown wires and realised that our suspect was heading right to the other side of the machine. The only electronics on that side was the position detector. The positioning screw for the lamp assembly had come loose and the lamp supply was being earthed onto the machine frame. It was the lamps again! Fortunately the power supplies never did fail.

### **Shift working**

#### **Qualifications**

The qualifications of the London Maintenance engineers were HNC, HND, Degree or Postgrad Diploma. It must be understood that in the 1960s the level of Maths studied to obtain an HNC was beyond that studied for an MSc. in 1990.

#### **Not all body clocks are the same**

By 1965 we worked three shifts. They had to be 9½ hour nights (with handover overlap) so that the Morning shift (8½ hours) could get in by train and the Evening shift (7½ hours) could get home. Soon afterwards Atlas was worked at weekends too. We then found that there was conflict between maintenance engineers who wanted to move earlier at each



change (morning to night to evening) and those who wanted to move later. It was a body-clock thing. Some felt less tired as the days on the same shift progressed; others got more tired and bad tempered. The majority voted for shifting to later and two engineers found other jobs in order to keep their sanity.

### **Shift patterns**

Eventually there were four shift teams. This could have meant working 3 weekends in 4. We decided to work long weekend shifts of 12½ hours. This resulted in two long Morning shifts, starting Saturday, followed by 5 normal 8½ hour Morning shifts finishing on Friday afternoon. There was then a longish weekend followed by five 7½ hour Evening shifts. Night shifts came next, beginning with five 9½ hour shifts starting on a Monday and switching to two 12½ hour shifts from Saturday night. By this time one's body had got used to working nights. The rest of the week was free, after sleeping time on Monday.

### **Hot showers save time**

Body temperature at night followed its usual pattern despite the body partly coping with weird meal and sleeping times. A lost pre-pulse fault at 2 a.m. could be a disaster because ones brain could not think well enough. We found that fault-finding time was reduced if one took 15 minutes out to have a really hot shower for ten minutes. This hot shower raised the body temperature well over one degree Celsius and thinking was a lot faster and more accurate; just like that at the beginning of a fever.

### **An expensive doorbell**

Someone had to answer the doorbell at night and unlock the front door. For the engineers this took at least two minutes. With machine time charged at about £750 per hour this "cost" over £25 per trip if we were fault-finding. We soon got a security man to mind the door at about £25 per week.

### **Yoghurts, beans and bacon**

London University used to leave food for the night shift operators and engineers in a fridge in our kitchen on the ground floor. We took it in turns to cook breakfast.

### **How do you cook baked beans?**

One female operator kept ducking out of her turn at cooking. Eventually she was stopped from escaping. She admitted that she had seen how we cooked bacon and eggs and could probably attempt that but she had never done any cooking at home. She asked how one cooked baked beans, did you put the tin in the oven perhaps. Another operator asked whether she had seen the Campbell's condensed soup ads at the cinema or on the TV. She had. "Just cook them like that" he said. We all went away sniggering while we left her to get our breakfast. The laugh was on us. She had obeyed to the letter – we had pale looking beans floating in a thin, orange watery liquid because she had added a tin of water, as directed.

### **Above our touch**

It was the days of "giant electronic brains". People who worked on computers gained kudos. We had beautiful girls in the punch room and others on-shift as operators. Here are two tellable stories about one young lady.

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- She would tell us about her famous model friends and the latest parties she had attended, such as those of the Rolling Stones.
- She came in late for one night shift. She had had a wedding reception in her flat. We asked if she had had difficulty in changing into her work jeans when surrounded by people. She laughed and replied that they were not using the part of her flat that she normally used. She thought that there had been about 150 guests.

### Ultimate fault-finding and redesign

#### Awe, respect and affection

David Howarth and Yao Chen were the last line of defence when things went wrong. They were both universally respected and held in great affection. Neither boasted of their ability; it was not in their natures; but their ability and good nature shone forth in their work.

#### Software – David Howarth

David Howarth was a god to us maintenance engineers. He could tell us roughly what was going wrong in the hardware of the machine – that was good. He could also modify the Supervisor software with a remarkably small chance of messing it up. We held five generations of Supervisors on tape. We rarely had to go back to “Grandfather” with Dave. The only time he would not explain what he was doing, when asked, was when he was dropping with mental and physical exhaustion. Other – just very good – programmers had a 40% chance of messing things up with a modification and we occasionally had to go back to “Great Great Grandfather” Supervisor.

#### Hardware – Yao Chen

Yao Chen was expected to solve any hardware fault, and did. When not “working” he was affable and amusing. When Yao was at the Engineers’ desk or had an oscilloscope probe in his hand he was totally within his own head. We would realise that he had not eaten, get him sandwiches, and tell him they were his. Almost invariably we had to hand feed him little later. He had to be told to open his mouth, then bite, then chew! He was also famous for leaving it till 2 a.m. to book into a local hotel – then leaving it at 6:30 a.m. having only seen the night porter. Fortunately he always used the same hotel and the night porter adored him as much as we did.

#### Visitors

##### A BBC film crew

The BBC recorded a program about the machine. I cannot remember when. I do remember that we had to keep the tapes on the decks moving to provide a moving background. There was also a troubling reflection in the window glass of the tape tunnel so we covered the reflection with a large notice reading “This is a NOTICE to cover a reflection”. It was readable on the broadcast output.

##### Queen Elizabeth the Queen Mother – University Chancellor

The Queen Mother (Chancellor of London University) came (from Ascot I think) to view the machine and was obviously uninterested. She liked the rainbow pattern of the hairbrushes in the fixed store. She ascended by the open spiral staircase declaring that the (car) lift was uselessly slow. The only male in the party was an 18 year old gentleman in waiting.

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He was very interested and kept escaping from the tour to chat with the engineers, only to be dragged back by one of the ladies-in-waiting.

### **Sir Basil de Ferranti**

Sir Basil de Ferranti visited once. It was probably while he was an MP. He wore a brown tweed jacket and had about ten pin-striped gentlemen in tow. He removed his jacket and flung it over the back of the engineers' chair then ignored his group to chat to Yao Chen, the designer, who was on site. Yao was not a manager, just an extremely good and trusted engineer. The horrified looks on the "pin-stripes" faces showed that strict protocol had been broken and also that they knew nothing about the value of top engineers.

### **Arthur Humphries – ICT MD**

Arthur Humphries, the then ICT Managing Director came to London after very many months had been spent negotiating the payment of the sum (£1.5m?, £2m?) outstanding for the Atlas. He screamed, jumped up and down, threw a tantrum and demanded money there & then. He got it. That evening he told us he would never have won a reasoned argument and took us engineers out to a pub to celebrate.

### **You must be the White House**

One evening Marian, the operator on the 300/600 baud phone-in data-link had a call. "I must speak to X... Put me through." said an upper class female voice. She was told that she had dialled the wrong number and that this was the Atlas computer. The caller then insisted that as she had rung "The White House" she must be speaking to The White House and Marian was deliberately not putting the call through. Marian, who could also speak posh, replied that she would put madam through, but the caller would find that this really was a computer. We never found out how long the call lasted.

### **The goons**

Occasionally there were important secret jobs to be run such as reading the ½ inch tapes of a disastrous missile test launch. First the khaki-clad, rifle carrying, soldiers turfed us all out and secured the computer area (except they never saw the wallpapered door in from the coffee bar). Next the top brass arrived, I think with a police escort. Sometimes someone had to be called in to help them out. I had not been positively vetted in those days so it was never me. Eventually the brass would leave and the khaki-clad armed goons would let us back in.

### **Other Ferranti Atlas Stories**

#### **Bedtime stories**

I used to tell computer maintenance stories to my very young sons at bedtime. They liked them. It does not seem to have harmed them.

#### **Shoes to grip**

I baffled a shoe salesman in central London when I asked for laced shoes with a fine ripple pattern on the sole. They had to have a good enough grip on a polished floor for me to be

## Atlas anecdotes

able to push a three Hundredweight Ampex tape deck between the Tape Tunnel and the ground floor workshop. I did not care what the uppers looked like or what colour they were.

### **Ferranti Mercury Stories**

*Three of the maintenance engineers on the London Atlas had been engineers on Mercury sites – London University, Shell and BP. Also the cleaner had previously cleaned the London University computer room. They all told stories of their experiences.*

#### **Shell**

##### **Payback in a month**

The computer was delivered a month before it was paid for. Shell ran a program on it which optimised their shipping and decided to implement the output for a month. I was told that one quarter of one percent was shaved off the shipping bill and that was enough to pay for the whole computer.

##### **Putting the clocks right caused faults**

Occasionally data on pre-written magnetic tapes could not be read early in the morning but could be read later in the day. Some tapes had been written fractionally too fast and others fractionally too slow. The tape decks were synchronised with the electrical mains frequency so this variation of speed was not expected. Investigation showed that the National Grid actually maintained the cycles in a day constant in order to keep the electric clocks (driven by synchronous motors) telling the correct time by 6 a.m. Between 5 a.m. and 6 a.m. all the generators in the country were adjusted, while under light load, to make up for the gain or loss in the previous 23 hours. The mains frequency was never out of specification but the difference between extremes was too much for the tape decks to cope with. A ban was put on writing tapes during the dangerous hour. All could be read later in the morning

#### **London University**

The Mercury was often used overnight by postgraduates to develop large programs. The engineers liked to sleep through this but could be wakened if the system crashed and needed restarting. The cleaner came in, at 4 a.m. I think, to clean by the morning. He was fascinated by the computer. By mutual consent, the engineers taught the cleaner how to restart the machine. The cleaner was overjoyed to be one-up on the postgrads and the engineers got their beauty sleep.

#### **All**

All engineers learned to work on “live” machines without getting electric shocks – well not frequent shocks. The ex-Mercury engineers training on Atlas did holiday cover on their old machines. This is when they found that through working on a low voltage transistorised machine they had dropped their guards. All got shocks from the valve HT lines on Mercury.

### Ferranti Pegasus

*One of my managers was an ex-Pegasus engineer. He was proud of the following tale.*

This engineer and a colleague were self-training on Pegasus one evening in an otherwise empty Ferranti factory. For reasons probably aided by alcohol they decided to climb on the computer desk and sing. They chose "We are the Ovalteenies" from a popular advert, this necessitated linking arms, doing the correct step and kick and singing loudly. They were surprised to be greeted by loud applause. Basil de Ferranti came out of the gloom with a party of visitors. He politely asked them not to give an encore – ever.

### Ferranti Orion

While I was on the shop floor at the north-western end on Atlas there were several Ferranti Orions being commissioned towards the south-east end.

The Orion worked on a radical system using currents to signal ones and zeros rather than voltage levels. Slight variations in the contact resistance of plugs and sockets made them very temperamental. This was especially so because of the dirt pervading the factory interior.

One problem was unexpected and difficult to detect. The current transformers on the inputs performed logic by allowing the nulling of the output by having opposing currents in the two input windings. Some would not cancel properly and gave a marginal output. The input windings were of fine wire numbering thirteen turns, each hand wound on a small ferrite doughnut. The problem was eventually traced to a superstitious woman in "10 Bay" who would not wind 13 turns twice but did 12 and 14 instead – this looked almost the same and passed inspection.

### Other Atlas memories

I understood London University Atlas time was charged at £750 - £800 per hour during my time. We used to joke that it cost £25 for the two minutes taken off repair time to answer the door bell and open the front door.

People now think in bytes. It probably needs to be stated that memory was in 48 bit words + 2 parity bits. Each 24 bit half word had its parity bit and was addressable as four 6-bit characters. The core was actually built to access 2 words (odd & even addresses) in one store cycle.

In my time there were only 8 x TM2 Ampex tape decks and the two ½ inch. I have a vague memory of Brian Hughes (later engineer I/C ?) telling me that the tape system was later changed. I have had no contact with him for over 40 years.

BP used to run their "13 Refinery" job some weekends. It was a massive matrix and stopped when the iterations only saved £10k a pass. It was started on a Friday night and usually ended sometime during Sunday afternoon. It used tape buffers and all the tape decks had to be tuned to run this without the servos failing. As the tapes wore out we

## Atlas anecdotes

sometimes had to adjust the gain on the read-amps while the job was still running then wait for the next dump before replacing the worn-out tape.

One shift managed to process 500 jobs in that shift. The jobs had to be hand-picked to have a short run-time and have very short names. This was before Dave Howarth had extended the buffer area required to hold program names.