FACT/ITEM GRANT
DAI EDWARDS INTERVIEW
26/05/04

Didn't do national service. Why?

Very small team in early days.

Users: story about crystallography, and that discipline being stuck, at a point when they needed calculations done and it was just too inefficient to have humans do this. Dai really keyed into this because he said it helped them design the next model of computers around their users.

Constrasted this to Atomic Energy Agency, who just wanted the next and biggest and weren't interested in giving them feedback.

65th line, added extra line of code on the Mark I. Something Newman wanted. Turing wanted random number generator; Dai couldn't or wouldn't say why he wanted this. Seems either secret or personal or just unknown.

When he arrived, anything having to do with digital was "dirty word". He didn't say much about this, but when I asked why: because there were particular ways of analysing digital pulses and these weren't well known or respected. Asked him if this was thought to be a pseudo-science: said yes.

What motivated you? Didn't really say.

Sounded to me like there were some conflicts over who the appropriate user was: he resisted the word "conflict". Turing v. Newman v. applied sciences v. commercial etc.

Said Turing was very private man. Had friends that came up to use the computer.

Shared digs with Ferranti men.

Never talked about Ferranti people. Wonder if there wasn't a kind of snobbishness of Uni people to Ferranti. People.

Had 2 patents on virtual memory.

Wouldn't talk very much about his own contributions.

Stuff arriving from TRE in wood crates and everyone taking bits home for heating. Still on rationing when he arrived.

"Brass tube" was not this but actually a casting (for original Magnetic drum store).

Talked about pleading on bended knee to FC Williams to come as a researcher. They had gravitated to computers and digital after taking a Class with FC in his final year. First years were physics, last was electro-technics (all with hands on component).

1948, baby finished in June. Then Dai and XX arrived and started working on Mark I.

Power plant was what he worked on first (getting DC electricity to be clean; had to punch hole in floor to get cables through to floor above).

Then started work on input/output, attaching the paper tape, particular for Turing, worked with closely on this. Turing provided paper tape reader.

Got a visit from FC almost everyday, even though he was busy with other things.

After this, working on a kind of router.

Eventually took a PhD.

Didn't think original Baby and mark I technicians were important at all. Machine shop next door.

Mark I: tasks: CRT, computer, Magnetic Drum (his friend from undergrad worked on this).

[Williams interested in drum?]

2 differential analysers in a room next door. Directly opposite was engineering shop. Next to that, two technicians had their rooms. Technicians would make up circuit designed by one of them, they would come in at night and test new circuits (when no one was there to look over them, and they could think better).

First thing Dai had to do was read Kilburn's thesis on the CRT. Also had to draw out by hand schematics of the Baby.

Eventually made an assistant lecturer, wages paid by grant from Royal Society. But didn't have to lecture at first. For 5 or 6 years. Started in 58, 60.

[what happened Toothill? No one ever mentions him. Why was he not number 2 behind Kilburn? Dai seemed to become this.]

Had Mark I and Mercury running at same time. Run by computer service.

FACT/ITEM GRANT
CHRIS BURTON INTERVIEW
26/05/04

Came from Central Africa. On Winchester Castle. Went to Birmingham to study EE.

On the boat he and a mate saw an article "electric brains" and was bitten. 1949 (?).

Then at Festival of Britain, 1953 (?), saw a demonstration of the Nimrod playing game of Nim. He was dazzled by the spectacle of it. Volunteered to play.

Senior year of uni, built a machine to play noughts and crosses.

Did national service for 2 years.

1954 (?), joined Ferranti to work on Perseus as technical supervisor. Which sounded good, but was really just a technician for that computer. Meant that he was given a single machine and had to babysit it for a year.

He spent 6 mos in Bracknall in training, working with the design team to build Perseus. This was a Ferranti specific machine. Built in parallel to Mercury.

Described two Ferranti teams, each building a computer, one team working on university designed machines, Chris's team was working on descendent of Elliot brothers machines. Commercial side only. They built the Pegasus.

Then shipped off to Stockholm for a year to take care of a consortium of insurance companies and their new Perseus.

Said that really, the company was disappointed in service of machine in the end, even though he was very laudatory of Ferranti.

He loved working at Ferranti, said he felt very lucky to get a job there. Said it was the best [something] technology company in the UK.

In Sweden: noticed how much cleaner it was., (story about running hand down handrail and it coming away black). Modern furniture. Things more expensive. Part of being in a country not hit by the war, not rationing.

It was hard work: constantly busy. There was a daily routine that involved testing the valves. Thousands of them. Pre-emptively. Had a test rig that could tell when there were losing reliability.

Then emergencies would come up, and they would have to fix it quickly. Time down was time the company wasn't running.

Story about "biggest emergency": turned the power up too high, and all valves (2000) started to glow red, got it down in time.

Described early Ferranti as very encouraging of creativity, personal project. Built what he said was the first digital clock (from noticing that a computer was able to keep time). F valued the time he put into this. Thought this was good, but also part of the reason they didn't make money.

Later, this atmosphere changed.

Worked on radar in his national service.

Baby Rebuild:

Got to work on some other rebuilt project, this gave him idea to do Baby.

Also, had gotten interested in the history when he was still working. Started to collect important objects.

Joined Computer Preservation Society. Went to conf. At Science museum. Met people doing rebuild of colossus. Also were building the differential engine.

Eventually made long proposal, gathered a team of old friends, including his old boss at Ferranti.

Began by working on CRT. If this couldn't be made to work, the project would fail. Did this at his home. Got it to work.

Farmed out the tasks to his team, they would each work on their part, and met every Tuesday. Timetable: first year get everything built; second year put it all together. 6 mos. to test it. 3 months to move it. 3 months spare. (?). 3 year project.

Hard to find racks (story about them holding up a guy's garden).

Hard to find buttons (story about spitfire and the salvage yard that found them). Only found them because he noticed and remembered a specific pattern of holes in the metal of a picture.

He worked between circuit drawings from Dai's notebooks (but from 1949, missed about 9 mos of work), and photographs enlarged (Alec Robinson took them, series of 24 he took for paper). Then eventually put photos in computer, used this to find scale, had the parts cut.

Problem: didn't have picture of back, had to guess what this looked like, inferring from the front.

The part he knows he got wrong was the wire; he knew he couldn't find the right kind, but he should have gotten bigger gauge.

Story about the cardboard box being authentic (came from CRT).

3 6" CRT and one 12" in Baby.

Writing on the back was a guess from asking people. Writing on front came from photos.

"Recognition is better than recall"; talking about showing the Baby to the old pioneers, and this triggering their memory in a way that could never have happened in the abstract. When they saw that something was right or wrong (the 12" CRT), they would notice on the rebuild.

FACT/ITEM GRANT
HILARY KAHN INTERVIEW
25/05/04

Came from S. Africa by boat. With her mother, father dead. And sister.

Got into London Univ to read classics. Had to do A-levels first. Three years there. Saw an advert on notice board: course in computer science at Newcastle.

Had a spot at Durham and turned it down when she went to look at it (classics).

They wouldn't let her work on programming at Newcastle because she didn't have math or engineering background, so she did a business course. Sponsored by English Electric. Worked there for a year.

Hated that.

Worked on XXX machine, which she loved.

Asked her about what machines she loved and why: she said it was more about heart than head; said everyone likes their first machine.

Worked in Germany in Siemans for 3 weeks (as translator).

Saw teaching post at Manchester, junior lecturer, 196X. Working under Morris X. Wanted her to work on compiler for Cobal. Didn't want to do that.

So, started working on the simulator. A way to test that things are going to work without having to build. This was Dai, leading team working on MU5. Built simulators for them.

To make platon was automated. Printed circuit board. To design it, Dai wanted not to get too many wrong (ICL was doing it and getting half of them wrong). She would test it in computer. Then carry it to CBG, get the disk backed up, then take to ICL, then they would use that to control the machines to make the platens. Errors had to be corrected by hand in final platen, the pink wires are those corrections. In the end, there were only 2 that failed, but that was because specification changed. Not Hilary's fault.

From that she moved in CAD work.

Early on: she looked at translation programmes. (actual language trans).

When she arrived, the dept. was 10-12 people. With some ICL people, she said she couldn't tell difference between them.

Didn't get along with Morris. Nor Lavington.

Said Kilburn is complete opposite of Maurice Wilkes. "Simpler", not at all "pretentious". Wilkes was the opposite. Really relished his powerful position.

Clearly has respect for Dai Edwards and Tom Kilburn.

HILARY KAHN INTERVIEW
NOTES

2:20 at school, wanted to be a chemical engineer, thought table of telements was most fascinating thing.

Mobile gas gave offer of scholarship, s. Africa, 7 or 8 years (working that long after getting PhD). Too long. So went abroad.

They all went, mother and sister and her.

Offer of place to do maths at Durham.

1961, Jan 7th, very cold, date they arrived. Had 27 tea chests at Southampton. Settled into 1 room in London. Hated Durham. Did a levels.

Did degree in classics. Wanted to be archaeologists. Got turned away by British Museum (becuas she was alien).

Saw add on wall, "come do computing in Newcastle". Had seen whirling things, maybe a computer, in London.

6:20 Had no maths degree; so had to do data processing and biz administration.

They had a kdf9 computer at Newcastle. Stacking machine. Good for hand coding of compilers. Excellent; could push things down on stack, then optimize when you got them out again. Nothing to do with ACE.

Was quite happy with computing.

8:20 Newcastle got her funding from English electric; so had to work there for a year. Stayed over summer and wrote stock program for a company, in machine code. Many years later, they were still doing it.

Went to Kidsgrove. Near stoke on trent. Lived in Burslim.

10:00 For that year: she thought she would be a programmer, but they sent her on a training course in London, complete waste of time. Working on really uninteresting software. First told her to maintain the OS (gave list but no documentation). "When there were problems, de-bug it". "Then they all left the room."

This was System 4 (essentially IBM 360 "writ small").

11:50, technically, it was a puzzle to work with it; inner instructions were null, did nothing. The OS would plant instructions in null store, they obey them. When it crashes, you have no idea what caused it, because what was put in null wasn't what caused the crash.

Had line printers and card readers. No paper tape. But did use that in Newcastle.

13:00 the peripherals then had no computers in it; they obeyed instructions that were hard coded into them.

Never was a context in which she would have gone "under the hood." From 5-10pm each day, one of the students would operate the machine. Did it the first night, having never seen a computer. This was Newcastle.

15:10 Newcastle: work had vicorian terrace with double glazing. Console of machine was flexiwriter, to type and run paper tape, input/output, could also print with it.

Sign next to window: in case of fire, use flexiwriter.

Operating computers was closest she ever got; never worked with hardware.

16:20 if machine was bust, English electric would come, they stood and moaned. No one in department could have used it. Just "users", only software.

Had never heard of Manchester. Not impressed with English Electric, management nor work.

No intention of coming to academic place. Cannot say why she applied, but saw ad for assistant lecturer, so applied.

18:10 At Newcastle: the "does anyone speak German" story.

Teams of people sent to Munich to work on Spectra machines at Siemens. English Elec used them at night; Siemens during the day.

20:00 when you apply to university, invited to visit, the invited back for formal if they like you. Re-convened panel of interviewers for her, then got job.

Kilburn, Prof. Joan Walsh in maths was one she most remembered.

She came because there was job.

Machine: Atlas was in use when arrived, in process of designing MU5.

22:30 the way to use it: put paper tape into box and waited. Or if you really needed to use it, take it along at night and put it in yourself. There was no smooth service.

She liked to go at night and use it yourself. To play. Hours. "Programming was a handwriting job: pencil and paper and a rubber."

24:20 didn't want to use Atlas; wanted to work on OS. Put her with Derick Morris, to work on languages and compilers. Didn't want to work on language.

But set off to learn about compiler compilers. Derick wanted her to write COBAL compiler, but really didn't want to do it.

26:20 Why? Didn't leave her time to work on compiler compiler.

27:17 engineers were beyhind on MU5, asked for engineer's assistant, Hilary volunteered to get out of COBAL writing.

27:45 stayed lots of night running stuff for ATLAS, but often didn't work. But it was the simulator not the ATLAS (to see if hardware was correct before installing it).

28:28 John May (PhD student) and her set out to write a simulator. She would take weeks before would sit in front of computer; he was more "hands on."

29:20 describes simulator function.

They used their simluator for MU5. story about platters: they had the money for 100 platters (the thing in the gallery space is about 6 platters). ICL was throwing away about 50 percent of them in any one design. The department had money for precisely 100, built machine consisting of 94. And it worked; a lot of that is down to simulation. Got large numbers of bugs out.

She enjoyed that.

32:10 that took her into computer aided design stuff, did that for ages and ages, wrote simulators,

Brian wrote program, program to do wiring of memory (the lists in which the wires had to be put in), that he claims is the first CAD program.

33:20 didn't like Atlas autocode particularly. Switched to working on compiler compiler after that.

Brooker was leaving as she arrived.

34:10 the Scene at the time: everyone was working on MU5 at the time.

She came in 1967.

Dick Zobel came along and didn't work on MU5.

Jeff Riding didn't work on it either.

Brian didn't either; he kept on with compiller complier.

NO research groups; they were all working on common research thing. There were hardware and software people. Lots of ICL engineers were included.

Had no plotter, so used to take the replaceable disk, drove to CEGB place in X for backup, then to ICL, onto shop floor, find a machine, asked to use a machine, load onto that, then available on their system for rest of work to be done. Not the world's smoothest process.

37:10 why did they build the MU5? Supporting OS and compilers. Had basic instruction set so that you could handle odd lengths of data effectively, in order to support OS and compliers. It was a clear issue. The idea of the OS provides a buffer from the hardware, don't have to drive the peripherals yourself. That gives you compilers. All of that was seen as getting in the way of me the programmer getting the most efficiency out of the hardware that I'm using. If it wasn't for damn OS, my program could run three times faster, because I know where I've stored the program on the disc. But it takea a long time to program this way. But never designed before to support this kind of infrastructure. Before, made only to support subtract and add.

40:00 but even to the most ardent coder, you could write more quickly. Now, nobody expects to write better code than complilers produce. Then, the complier did sometimes make mistakes.

AT time, there was still the thought that students should know how to write higher language and machine code. With any part of program that would loop a lot you wrote this yourself, to be more efficient.

42:10, if you only get one shot at computer every 24 hours, then you spend a lot of time working on paper. You always hand-check what you wrote. If you leave it overnight, and it falls at first hurdle, then you waste 24 hours.

44:30 simulator; got a good sense of how hardware was working. Hardware and software were very separate for most people.

She often wrote software to support hardware design, so had to know something.

46:00 Three Rivers machine from Pittsburgh. They had raster graphics. You could do anything to any spot on screen. That was amazing. You could do nice graphics. When busy, there was a

little bee that flew around.

47:40 question about loyalty to machine: how do you evaluate a computer: it's an emotional not a technical comment. Most people like the first machine they played with. E.g. KDF9, she loved that. Could have used it forever. Never used Atlas. Never liked MU5.

50:50 students and the engineers were family of users.

AT this point, engineers were fixing hardware problems, but they weren't building the computers.

The OS was basically working.

ICL was doing a lot of the work: the university was paying cost for platters and things from grant. ICL sent engineers here to learn about tech. Could not tell the difference between univ and ICL engineers, but all claiming not to be transferring info.

54:00 when did you start to move up in hierarchy. 1969, simulator. Around Xmas, started working on associative store tests for MU5 (for special fast store).

55:50 conflict with Simon about this project, intervened by Tom K.

56:48 what did one do to be recognized at the time; she doesn't know. All she ever did was what interested her. They had freedom to do that.

Did you feel engaged with anything outside Manchester? NO, absolutely not. Nobody ever said read or publish anything. They were doing much more interested stuff than IBM. Had students, you could get them to do things.

1:00 rarely ever spoke to Tom: it was big dept and she had lots to get on with.

TAPE 2
1:00 MU5 was this end of era: no, started designing MU6. Spent lots of time on that.

"World's most boring machine"; like MU5 but small. Not sure what problem it was solving. Introduced data flow architecture. Some people watned to break away from Tom's conventional stuff. '77, '78. Thought data flow architecture was waste of space. Letting Dai run the department. Drifted into different things at that point.

Fragmenting? Yes, getting large. Not everyone can work on single project. No longer a small core of academic staff (15, 20). But at 30-50, all pointed in different directions.

Dai: was there strategic thinking about what should be strengths at Man? Yes. Brought in theory and formalism to teaching of computer science.

5:00 teaching changes brought in by Dai.

Her first lectures were to third years who had been doing computer science longer than her. Started lecturing on sorting.

When you taught, what were you preparing them to do?
7:45 WE knew there was a range of options for where they might go. Included hardware and software. Very general. Not everyone was going to be either academic or commercial. They learned COBAL.

Required: basic hard and software.

They all had to have A-level maths; still are. Still have maths on course.

How esoteric did the field feel?
11:10 I don't know. I have a feeling: the sorts of things that interested her had nothing to do with normal life. If you were working on OS, compilers, design tools for engineers, it was a step back (further inside the industry). But some people must have felt more connected with "real world." Did have fleeting interest in automatic language translation. They weren't everyday life, but it would have been really interesting.

13:00 Women: Mary Almond was there when Hilary got there. They had to share an office.

Ladies loo: nearly forgot in the Kilburn bldg.

Never been a matter of any observation to her.

"truly not been an interest for me."

But does tell story about Brian and head of dept going to a meeting with all women and thinking this was brilliant.

15:50 early on, did represent the graduate exam committee. They would all say "how can you do a PhD in computer science?" They didn't think it was a real field.

17:15 when did dept start to get less isolationist? It wasn't that they didn't go; just occassinoally. 1968, most people went to Edinburgh conference. Dai and Tom and so on would go to Royal Academy or Russia, etc. Dai did more, Tom hated traveling.

Good dependency network built from old students from Manc populating other faculties.

Brining in people from outside started to change the dept.

19:00 when did people start going to US? Never, not in huge numbers.

19:40 IE would never allow her to be a Member, but could be a fellow. Because she didn't have science degree.

21:20 description of using computers physically.

Atlas:

26:00 often worked at night, fewer interruptions. Esp. on MU5, spent years working in tiny room there. No external light. You don't notice the time. Ran MU5 autocode. Eventually used RCC (complier compiler system, from Brian).

Derick thought they were the only programmers, but she was another level of programmer. He didn't care about users. Hilary was user.

28:40 story about machine going dead, silent, no flashing lights; thought she had broken it? But it then began again; it was such a tight inner loop, you couldn't hear the machine moving along the tape or see the lights moving.

Lots of her life spent at 4am de-bugging. Go home at random time, feed the cats, then appear at work again.

29:40 funny rituals to make sure the machine would work? I don't think so. Just make sure the little holes in tape or card were clear. Worth being careful.

Knew how to sort out tangled tape. Knew how to repunch holes in repairing tape. For paper tape, a little machine and a pressing down thing. Cards: more difficult. You could stick the chads back in again, and if you were lucky, they'd stay. If punching without machine, then you had device with buttons on it. Loading the paper on line printer. Large amounts of dust produced because paper is going through at reasonable rate, sprocket holes. Knowing how to clean this was important.

In Atlas, you could keep milk and inner. MU5 the same.

In Newcastle, on day trip, saw income tax machine for UK, Benton; rooms of computer, ceiling high, really hot valves.

MU5 looks exactly the same as NASA equipment to send astronauts to moon.

35:20 the Pub: if going back to work from pub, competition for who could write the most efficient program, to see who could make it run faster. To see who was most sober. A little bit "boys toys," wasn't so interested in that.

36:17 Didn't go to pubs so often.

Brian
U of Manchester
Interview debrief
24/05/04
4-6pm

Arrived in 1960 (?) for PhD work.

Brian didn't interact very much with the other students.

He was recruited by Brooker from Leeds on the basis of his master's work, which was an exploration of the Atlas' compiler compiler. Invited to do his PhD at Manc. He chose a PhD topic that was not directly relevant to the work on the Atlas. He came with 2 years of development left on Atlas. But played a doubly marginal role because 1. he was working on programming, and 2. it was not a programming task directly relevant to Atlas problems.

He had heard a lot about computers, decided to do his Master's work on them, and said that in certain communities, there was sort of a feeling that computers would be really important (although not, he meant, in a popular sense, but more among a community of scientists, maths, and some business). He thought it sounded like a field with strong applications and a good future. But he had no idea how popular they would become. He also said that he was attracted to computers because he had read maths at Cambridge and not done very well.

One project he worked on after PhD was natural language programming.

No connection with the machine for user. Difference when able to use machine directly.

Isolationism of Manchester - arrogance. Self-deprecating, Brian and Hilary.

Kilburn thought that Man was best in the world and there was no reason to look outside of themselves. But Brian did confirm that there was an air of competition.

Manchester had a reputation in UK for being isolationist. Snobby?

Programming second class: the attitude was that the use was not considered when we were making the machines. Kilburn especially not interested in the user. Whereas Cambridge, by 1950's, was far more interested in programming. Cambridge had stock library of sub-routines, etc. Manchester was much more interested in the hardware side, solving engineering problems. Not until Brooker came to Manchester was programming taken seriously. Atlas hard to use despite two level store but much more powerful.

Terminals on main frame

Never said what people actually did. What data was crunched.

Magpie at start due to no one being a computer scientist rather than a conscious choice.

Time saved in ease of programming gained in running on faster machine?

Brian talked about other departments being more math led, whereas Manch was more engineering led.

Compiler compiler writing straight forward text, "natural language code"

Old school programmers your sloppy. Machine corrects code.

Three teams on Atlas Supervisor, hardware, and programming.

ENIAC was America's big contemporary to Baby: both Hilary and Brian emphasised how important it was that Baby was not designed by committee, that it was done on the fly, by two people, with a very pragmatic goal. ENIAC, the opposite.

The Baby was "cheating", in that it only went as far as it had to in order to test the CRT. Couldn't store enough on it, mostly (magnetic drum).

Press: there didn't seem to be too many stories about it. It was too esoteric, too mundane in the tasks they were trying to accomplish. But they did pick up on the "electronic brain" idea (what is this?).

Did Manchester's focus on big computers hurt Ferranti: he said it was "about a draw". Yes, they didn't sell very many, but they did get some good solid commercial computers out of it.

Sound: you got a feel for the patterns of sound. You could recognise the sound of your programs. Brian knew when one of his programs was running because he would heavily tax the circuit between the first and second stores, and a big red light would light very brightly. He would sometimes look into the computing room to see if he could tell which person's program was running (in the program queue).

Process for using computer (1960, Mark I): write out program by hand, if you're really good you run tests on the program on paper, then if you're senior, you get it typed out by an operator, if not, you go into a big room with "flexi-writers" and type it in yourself. Then drop it in a box in someone's office and if you're lucky, you might get it run in a few hours, if not, then maybe a day or so. Then you check an "out" box where you can pick up a print out of the run of your program. Then you respond to any errors there were and repeat.

Sometimes people would get their paper tape tangled and have to seek out a particularly tall stairwell across campus in order to dangle the tape all the way to the bottom and sort it out. Brian says that sometimes you would be coming up that stairwell and be hit with falling tape.

He said it was definitely a time of "trepidation" and excitement waiting to get the results of your programme back. It gave you a sense of what your work would be for the next span of time.

When he got to work on the actual computer, it would either be after 10 at night, or often between 3-5 in the morning. When he got on at night, he would work hard during the day in order to make sure that he used his time well at night.

Senior people could have the results of their program delivered to their room, or command the help of the operators, or use the computer themselves if they wanted.

He had a really hard time coming up with actual projects people would do on the computer that was being hired out (Mark I) while they were building the Atlas. He didn't seem to have much contact with the users, and suggested that this was part of a systematic attitude of the dept.: they weren't that interested in what people were doing. Only Brooker took this seriously. Brian never mentioned a single project except his own "natural language" work with the compiler compiler.

Both Brian and Hilary say that the Atlas was really Manchester's most successful computer. After that, the MU5, was a design "cul de sac", says Brian. It was not the way the world ended up going, so was quickly obsoleted.

Discovery v. invention: he said it was more like invention, goal driven.

Were there comparisons made between computers and humans. Yes, he said immediately. He related this back to Turing, and to the idea that a computer could do what humans already do, but better, faster. This was the sense in which Brian talked about it, more than about

anthropomorphism.

Designers of these machines were very different than the users, at least at Manch. Though we have the sense that at Cambridge this was less true. And by Brian's generation, it also seemed less true. Brian had had the experience of using old "horrid" punch cards and a really bad old adding machine; his first work (and I want to say "therefore") was on programming. I wonder if one thing he's describing here is a difference between people with theoretical interests in computers as innovations, and people whose point of entrée was more as users of computers, who would then naturally care more about how one interacted with the computer.

trade-off between computing power and code: the more coded an interface one (programming language), the less powerful the machine was.

Turing set Manch off on a difficult path because the base 32 coding system he created was awful to use. Wilkes at Cambridge started with a very different system.

By the Atlas, this was much better, and they had surpassed Cambridge (because, he said, Cambridge's first system was pretty easy to use, so they had no impetus to develop a better one; whereas at Manc., their system was atrocious, so they had every reason to want some coded language.

Funding for ATLAS/MUSE: difficult because the gov't was (rightfully, he said) cautious about funding something that seemed to have no practical or commercial application. They are this was with every invention (he cited the Concorde and another airplane, TR2? As similar examples).

It wasn't until the 1980's, with Word-like desktop publishing software, that computers really became a mass market innovation. Before this, he implied that there were still the province of a small sector of society. He seemed almost most excited about this innovation (word), though not sure why.

DIY: especially during the building of the Baby, where they built everything themselves. But by the time of the ATLAS, they had a standing contract with Ferranti because it was too big a project for them at Manc to machine all of the parts. Ferranti was a partner in this work, though junior.

One man at Ferranti, XX, played a critical role (beyond all expectations) in solving an OS problem. Why? Brian thought it might be because Manc hadn't devoted anyone on their side to this problem (again: their hardware bias).

FACT/ITEM
BEN AND KRIS
NOTES ON INTERVIEW WITH DAI EDWARDS
16/6/04

Came in 1945 as undergraduate. Never been in his life before. "Really got sent here". State bursary said 'you will go to Manchester to do physics because he took science a-levels. First choice was Imperial College for chemical engineering. Got accepted. Got major scholarship. More lucrative state bursary to go to Manchester.

1:48: didn't want to be a burden to his parents.

2:00 in final year there, decided to do electronics. FC Williams came in Dec. 1946. Took first course he gave (first class, 47, 48). He as "inspiration". He was talking about "digital" or "pulse" techniques. The only one. It was almost a dirty word. Not the right way to go.

3:12 lectured on servo mechanisms (controlling speed and position). Collin Litting (new lecuterer in vacuum techniques). He helped investigate the CRT.

4:08 Tom Kilburn came with FC Williams (wanted to do PhD, registered as one, but was more experienced engineer than anyone else there).

4:52 We knew nothing about digital techniques, even when we took our finals.

5:18 pleaded with Williams to be taken on to do research.

Only five lecturers at the time in Electro-technics.

5:59 in final year, had to actual make something and give a lecture on it.
But always, two days/week you're using instruments in lab. Learning about accuracies. Hands-on when you're doing physics. It's not like an 'art subject" like Greek or Latin.

7:29 had to go down on bended knee because they didn't have any practical experience in engineering (trying to start an MSE degree). Graduated in 48 in electrical engineering. Williams accepted him and Gordon Thomas.

8:10 came up a fortnight early. Three activities: 1. computer itself, 2. work on vacuum techniques and CRT, 3. Still with computer, but magnetic recording on a drum.

Spent fortnight talking to people. Gordon worked on drum. Dai worked on CRT and expanding the baby.

Machine worked first in June 48. Dai came in Sept to expand the system.

9:21 Tom Kilburn always took August off. Some time with family; some time reviewing what the direction should be for following year.

Dai's first task: read Tom's PhD for typing errors. "incredibly useful".

10:30 tom's phd was on CRT and a plan for building the baby (as the only way to test the CRT idea).

12:00 In june 48, he didn't know about the baby. Only knew about it when he came up a fortnight early, in Autumn. There was no way of knowing as an undergrad. It was just after wartime; "things were pretty basic". There wasn't "normal university activity". FC Williams really had to build the department around the computing activity.

FC Williams came in Jan 47. Inherited a dept with no electronics and where the dept had just

been gutted by one prof moving with staff to London.

14:00 decided to build an experimental machine because Kilburn did so well in the first year with CRT.

15:00 Williams: did he have a plan? Or was he responding to events on the ground? His capability was in being responsive.

He had offer to go to National Physics Lab as engineer to help make the Turing machine operate. Turing had fallen out with his engineers. "Some dissension". The work had stopped. Williams wasn't interested in mercury delay lines.

Going to Manch was a choice to do his own thing. Did get pressure from TRE to go to NPL.

16:25 Dai's first job: fix a few power supplies (with Tommy Thomas). Also: in expanding the machine, needed more power. And power supply frequency varied too much. Need some rotating machines to produce power. Intalled in corridor underneathe a bunch of rotating DC machines.

We had more rotating machines doing computing than there were in EE dept. Not really true, but a good story.

17:58 story about having both hands on both cables, with power out, and got 300 volts. "Jumped a bit at that".

18:40 Treated very well when first brought in. FC had been his prof. Regarded him very carefully. But tom as a phd student and he regarded him as a friend, from day 1.

Also interesting: had come from physics, been there 3 months, secretary came to fetch him. A physics senior lecturer there; so a bit worried. FC asks him to help Dr. Braddock with his problem. He had come to discuss it with Dai. Dai was gobsmacked. Showed confidence in him, from FC. This was a really big deal for Dai. Knew what trouble was right away because of his experience with electronics. "I went up a step there."

22:08 thrown in at the deep end, and they would give you help if you asked, but if you succeeded without asking, so much the better.

22:30 describes arriving for the first time in 1945 in Manchester. All the chimneys were pouring smoke; he had grown up halfway up a mountain. Carrying leather suitcase; his dad's best; very heavy. Had to walk from London road to albert square to catch the tram.

No telephone at home. Couldn't communicate except by letter. Had double sided black sheet with his address sewn on one side, and theirs on other, sent laundry home to be done every week.

"quite difficult really". Rationing still on. Quarter glass of milk per day for tea. Gas pressure in room was a very small flame. Lived in old Victorian house with tall rooms. So very cold in winter. His impression of Manchester at that time was not great.

25:30 quite good at table tennis. Rugby in winter. Etc.

25:50 once you joined team with FC, did it get more serious? After three years in student accommodation, he was ready to be out into "digs". Met diff. People then. People from Ferranti, e.g. You met people in related areas of work, "that was quite nice".

27:00 with computer being on in small room, it was nice and warm. You were encouraged to go back at night. Without "tom and professor" there you were alone and could think better. G. Tootill designed some circuits and had them built. Took a week to build with two lads building.

"Quite useful" because they could apply FC's lectures to testing another person's designs for circuits. They would go in at night to put the "odd circuit in and expand the thing".

28:20 typical day: tom used to travel in from Yorkshire. Always left at 5. Not in until 9:30. We'd get in at quarter to nine. No later. FC had university business, but you always saw him once or twice a day.
Remembers: always trying to improve CRT performance. Dai got heavily involved in techniques. One day: FC there, had a problem, Dai goes to switch machine off, FC yells "no, don't switch off" because it took so long to power up again. So you worked with it live.

Always "action" going on. E.g. expanding the accumulator. Deciding to try a new form of time-base on CRT, hoping for improved performance. You were worried about 50 cycles coming in through mains. Should we change it to DC heaters on the valves. At one stage, without screening, if motorbike passed by you had trouble. Tested what kinds of screening gave the best result.

Lots of diff. Activities. Sometimes have to fix the power. Or people wanted to take photos.

"There was nothing really organised or really, well engineered…not specially engineered to look nice".

32:40 spent days in white coat with the computer. Wore coat because you would burn holes with soldering iron all the time. And the room was pretty filthy—didn't allow cleaners in.

Sign on door: "magnetism" [to ward clearners off]

33:40 Norman, Chris Burton mentioned him. Norman Calcroft, he thinks. A couple of technicians.

34:25 maps out the layout of building.

And Author Gledson, who did the brass casting for first magnetic drum.

Whole place was involved really. Wasn't a vast place.

35:20 once a month, a crate came from TRE, responding to list they had to make for supplies. The wood in the crates when home with technicians to burn.

36:30 initial CRT were absolutely ordinary ones: two snags: focus not good, and the contacts of ray rub off bits of graphite, and if those dropped on screen, you couldn't store at those spots. Those spots were called "phoneys" in those days.

Improvements: silver coating that wouldn't rub off; and better focus (and a clean screen from any point of view).

IBM: in early work, they built a factory in the country to make CRT and found that pollen is not very good for making these. Have to have really clean conditions.

Phoneys always reacted as noughts. So, if you had to use one, you would arrange the programme to always put noughts in the phoney spot.

39:30 hit on idea of test programmes, to get machine to test itself. Tell you what areas weren't producing right answer and so on. Helped you in maintenance job. This was dependent on machine running, e.g. if the problem was in arithmetic section, the machine could test itself.

40:10 [did you feel like the only ones in the world working on this?]
"No." In the first Dec, prof. Wilkes visited the dept. Distinguished man from Cambridge. When he saw the mag drum work, he invited tom Thomas down to conference in May 49 in

Cambridge. Gave paper on drum work. FC talked about CRT storage. Tom talked about the machine itself. Dai went, but escaped without having to talk at all. We travelled in FC's Riley. Took us down to Cambridge for the week.

Whole atmosphere was friendly.

Wilkes talked about his machine.

Newman talked about his work with Marsenne Primes on manch machine.

About 100 people, most from UK. Has original conf. Proceedings and orig notebooks from 1949 on. Record of whole machine.

42:40 described how problems about transfer system got solved. Began: we have to stand here and transfer it manually; "Dai, we need a transfer function". The desire to automate it.

[very esoteric bit here about reading and writing]

Writing would be slower than reading; because writing took more power and needed relays (so these were slow). Not pleased with this, but at time, this was only way. On reading side, had to have minimum of equip with amplification afterwards. At least one valve on every track. But needed 120 volt signal to switch actual valve. Needed to invent new power supplies to do this.

Problems would set you back 3 months sometimes. Before you could get to "proper design".

46:00 [were you moving about in the dark? One thing led to another?]

While this was all going on, turing or newman would come in with programmes. If you had magnetic drum, you could store these and transfer them down mechanically. Didn't have to use paper tapes all the time. This was tedious. Goal: once their programme is in once, they want to keep it there. But also, they wanted to be able to take tapes out and go away and read them. Had to have these facilities.

Turing, Newman: we were happy to do some input for them. But at some limit, they wanted to build mechanised systems for this (e.g. programmes).

He never knew colossus even existed. Tom might have heard the word, but didn't know anything about it. Turing and Newman knew. Newman came in 45, in maths dept. He wanted to use a computer. Felt it was time to start using dig computers for other activity than code. For general purpose. But didn't exist. He got grant from Royal Society to get one built.

48:00 Moore School conference: Turing supposed to go, but didn't go. Goode reported back to him. Newman at that stage interested in selectron, RCA. He thought it looked "best bet". He got leave of absence to go to US from Oct to Dec. '48 (?) to look at this.

Selectron never worked.

Newman's grant went to pay for them as assistant lecturers after a year of work. They were quite keen to stay.

But didn't have to teach b/c it was a grant and a computer laboratory. For a few years, didn't have to, but did eventually.

Dai eventually taught electronics to physicists. First class he taught was to over 100 physics students. (so got more popular).

52:50 [ask about Dai comment that digital was dirty word at the time]
Digital only started coming in with radar. Digital techniques couldn't be analysed in the same

way. Needed new methods. Those new method hadn't been rigorously checked, weren't approved of. E.g. Step functions (something changed instantly in time). EE, dominated by heavy electrical and some radio, this didn't fit in at all.

But did get popular quickly. Used to go to London to lecture at Borough Polytechnic. Very interested in this. E.g. How to make pulses, how to count various things. E.g. high voltage group wanted to be able to count.

55:00 not just doing computer work; did "investigative work" on other things; e.g. digital circuits (transistors), flat panel displays very very early on (difficulty: transistor techniques didn't exist yet)

56:00 " a new approach to doing things, and people didn't understand how it fitted in." In those days, things called Williamson amplifier for audio work, came out of TRE. Tommy and I built one for ourselves. These days, everything is digital.

[what changed this]
Took a long time; computers weren't well thought of in Atlas days, even with mini computer. Not really until integrated circuitry took off, smaller machine, more affordable, did things "really start to get interesting".

[who didn't think well of them]
60's, 70's: chief scientist said we only need 1.5 altases in the country. I have four and a half upstairs on my desk.

Misconceptions: took a mathematician to use a computer. Then you had the idea of a "translator" or autocode and this helped. Then OS: you didn't have to worry about how to arrange for input and output, you just asked for it. Now, there's so much waste in computers, with vast amonts of memory, you can do these things. But they're really inefficient now.

Not until 16bit on a chip that things really took off. Really integrated circuitry that enabled digital work to take off.

59:30 Integrated circuitry replaced the scads of wiring in between racks and etc.
the fact you could use a photographic techique and do this all without many errors.

Chris Burton
Interview Notes

2:40 How did he get interested in computers. Immigrated from Africa after WWII. Went to Birmingham 1949 from Africa. Came back by ocean liner, lone 18 year old chap. Other guy has newspaper clipping, "electronic brain".

3:50 Electrical engineer, always did projects on computers as undergrad.

4:20 Job at Ferranti, worked on radar in army, had no experience with computers.

1959, almost a mature industry by that time. Ferranti was top company in the country. Supervising computer engineer. But this is really just maintenance engineer (not so good as it sounds).

5:10 all computers then got one year free service, each needed one computer engineer.

Assigned to Perseus, have to work with designers to learn what you can about it. There were no manuals. Very good training in that you knew what your task was, to keep the machine working, the 2 months gave you a chance to get used to the machine, and work with people who were trying to make the first machine work.

Insurance co. in Sweden. Stayed for little over a year.

7:00 No formal training in computers. Hands-on, learning as you go.

When back, joined the next big transistorised computer, Orion. But he realised that he wanted to design not maintain, was taken on as a designer. Really began his career.

8:00 My degree wasn't good enough for academia; and wasn't attracted by it anyway. He was attracted by magic things computers could do. E.g. Festival of Britain, Dome of Discovery, Ferranti machine (while still at univ), plays the game of Nim, big display panels and big audience in the room. Giant brains or machines that could think. That sort of thing is what intrigued him:

10:00 not that it was powerful mechanical thing that could do job of your muscles, but it was something that could think.

Father and grandfather were both in industry. Family history.

11:00 how did you make sense of that first computer? I had read everything I could. Famous book: Giant Brains or Machines that Think, Edmund C. Berkeley. Annals of Computation.

12:00 electo mechanical machine, from relays, built a machine to play naughts and crosses. (as undergrad), did it in spare time, out of interest.

Prof. Told them about conversatizione at town hall in Birmingham, he and friend brought their machines there (naughts and crosses and also Nim). The mayor played them. "It was in the air, using electro-mechanical devices to perform mental functions."

13:53 we got it by reading, lectures.

Had you heard of Turing? Hadn't heard of hardly any of the British pioneers. Had heard of Berkeley. Didn't know much about Manchestre computer. Until came to Manchester.

14:50 more interest in what is happening now than in what happened 10 years ago. No sense of history at the time. Wasn't until much later that he became interestd in the history. Everyone's interests were now and tomorrow. Therefore, didn't know about the young

pioneers.

15:50 Ferranti was Manchester oriented, but wanted to sell to other parts of the world. The London Computer Centre, where designed the Pegasus (nothing to do with Univ)—this was built to have London sales presence. This created two streams: one with University and one commercially oriented in London. Perseus was a giant Pegasus. Same tech, same colour. It was just a very big version.

18:30 Within Ferranti, two streams: University and London. He was in London oriented. We didn't tend to talk; it was rivalry. We can do ours quicker, we can do it cheaper, we can solve more problems than you, or we did that ourselves and you had to have Univ help. Differences in culture and approach. They didn't dress up, they started at 10. We started at 8:30, "like it says in the book."

20:40 Tom Kilburn was considered a little bit awesome. He appeared to be quite severe. Seldom smiled or told jokes. Barely touched base with him at all during the time. Really only met him during the rebuild. Was nervous to meet him. But he was much easier than he had thought. But he had matured and retired by then.

22:15 Some engineers at Ferranti were associated with Univ, hard drinking irreverent lot, didn't obey any of the company rules, whose loyalty was much more with University. They were marked as such.

There were rules, about time-keeping in particular. You got knuckles rapped if you kept coming late. It was very relaxed for standards at the time.

25:00 first day at Bracknall, "here's your office" there was a big lovely window and lawn with rabbits, "lovely".

Really didn't know much about people several levels above him. He was a very junior designer.

26:20 only 6 people on the team.

Stockholm
26:30 They recruited a team of engineers who will learn from Chris and take over from him at the end of a year. He was stockholm chief engineer. We shared the work, though Chris was responsible for it. 2 Ferranti people, 4 of them.

6am – midnight, needed cover that whole time, the working day.

Been there 6months, went home, got married, rest of time had honeymoon.

29:00 difference in wealth between Sweden and UK? Cleaner. Hand on rail story (black with soot) in West Gordon. Skies so clear at night. Smaller population. More expensive. Cars cleaner. Living in capital city; used to living in Styx before.

31:00 everything was modern: pine, beech, minimalist, simple compared with UK's Victorian stuff. We were smitten by it.

31:40 what did machine do? Designed for financial and admin work. Main market was insurance biz. Used for consortium of Swedish insurance companies.

Only sold two ever: Sweden and Cape Town. No wonder they never made money on computers.

Worked at consortium called Data Centrale.

Had punched card reader for round holes and square holes (one company had one, one had

another).

34:00 All info stored on mag tape (before days of disk drives). All data on punch cards.

Carried mag tape to another room for printing. You could almost see the insurance biz physically. It was all visible. Quite simple. [interesting to compare to modern perception that all data on computer is invisible]

36:20 Anticipating the failure of valves. Everyday you take out 40 valves and put in fresh ones and test the ones you took out. You didn't want it to fail during production. The faults were nearly all in magnetic tape decks, card readers, and the printers—the mechanical things.

38:00 sometimes the data was printed marginally, and unreadable. Management hated this. Getting tape decks to be reliable was hard. Keeping clean, adjusted (so you don't stretch tape).

Ongoing development: bringing people over from UK to make changes.

39:30 It did improve their business but they didn't really like the machine. They did buy an Orion, then later bought an IBM.

40:20 Potential disaster: marginal tests, reduce the voltage in system by 10%, total power 25kW (huge cabinets, big a/c system). Took 90s to switch on the system, so valve heaters came up slowly. Fiddling with switches, went past limit stops, red glow, had over-volted all of them, 9 volts rather than 6, more than 2000 valves. No design safeguard to prevent that. Had to learn not to do that.

43:00 transition to transistors, Time sharing machines so the machine could jump about between tasks. He did some simple mods to Perseus to accommodate time sharing. Came in on Saturday to do it, to see how it worked. Very open, free experimental atmosphere.

45:00 creative atmosphere. Like being paid to do your hobby.

46:00 at end of replica project, wanted to give whole team a treat, recalled in Ferranti days, whenever they finished a big machines, the Ferranti family would entertain us to a "splendid dinner" somewhere, "for a humble engineer…". Marvellous restaurant on side of river Thames. So had big banquet with Sebastian hosting it.

48:45 free to do whatever you want; if you needed parts, you just applied to managing director. And they would approve it or not. Did lots of side projects, just because you wanted to. Orion was first computer to have time of day clock. He invented a way to display the time in digits on oscilloscope. Could read the time all day long in digits. Absolutely nothing to do with getting on with project. "World's first digital clock".

51:10 American counterparts were probably much more disciplined, much less gentleman's club, freedom to innovate. Might not have benefited Ferranti, but benefited industry generally.

1964, Ferranti sold to ICT/BTM.

52:00 If only we'd worked harder…lots of regrets.

Merging with rival group, "old fashioned mechanical punch card data processing people." "We didn't have disdain for them…but…"

Ferranti motto: "first into the future".

59:30 having to fit in with new computing culture, fit into the line, not being able to design how or what they want. [interesting about change to new capitalist model]

TAPE 2
Begin: still talking about IBM v. ICT/BTM

IBM were always reliable. The only was for ICT to compete was to do the same thing but cheaper—and that was very hard.

3:23 only switch on the baby rebuild when there are two people there, because it's highly dangerous.

Baby Rebuilt – 5:50
Left ICT in 1989.

From about 1960 onwards, he had been developing an interesting in the history of the old computers. Retained nostalgia for the old one. Squirrelled away bits and documents. Built up quite big archive. "Couldn't bear" to see the old electronic packages thrown away.

Mostly interested in the things he had worked on.

1987-88, learned that an old Pegasus computer about to be installed at West Gordon, last surviving working Pegasus. Threatened to go to Boston Computer Museum, Science Museum didn't want it, so ICT man created space for it to save it from US.

He helped get it working again. He travelled to demonstrate it. He had never been a Pegasus engineer, but knew it from Perseus days.

9:30 dismantled later to create more space for other things, put into store.

10:30 offered services as consultant to Science Museum to maintain machines. Out of this was born Computer Conservation Society (CCS). Was in this from beginning (Doran Suede).

Doran had ongoing project to build a difference engine. Tony Sale as well.

1994, realised that 1998 would be 50th anniversary of running of first programme. At that time, that date was considered to be key. Nobody thought of it.

13:00 end of 1994, proposal for building a replica of Baby. Frank Sumner in CCS as well. Sumner brought it to Manchester and championed it. They wanted a machine to go along with 50th anniversary conference.

They told him to get on and do it. Prof. Cliff Jones and Jenny Whetton were a part of it. Peter Hall.

15:00 Chris was project manager of this small sub-committee. Practical things. Space in university, how to plan this, getting funding. This carried it through 1995. Cliff Jones stuck his neck out to buy valves (£2500). They were the most risky and important part of the project. Before they had any funding.

Chris tried to make CR stores ("feasibility rig") work at his home. If he couldn't do that, they were sunk. They worked. In 1996, in town hall, make spiel about conferences, the project to build a replica, the city was going to promote "digital summer 98". At public launch, showed feasibility rig. Met many of the pioneers. Good start.

18:00 By 1995, recruited team of colleagues and friends to do the work. Everyone was at home, dispersed, only met occasionally.

20:00 quick description of how Tom K, Geoff T, and Norman in shop built the Baby. E.g. drew

circuit board on back of fac packet, gave to Norman, he built it with no drawing. He had always done it that way.

22:00 what they worked from for the rebuild: hand drawings from first computer, which all sat on "Tom Kilburn's Office" (called that in '48)

23:00, process for doing rebuild: wanted everyone to do CAD drawings at home, then Chris would check (because he couldn't do everything). Each engineer then built a chasis. Then people would bring their finished bit and and bolt to the racks. Every tues they met.

End of 1996, machine almost complete. Gave them a year to get it reliable. Then a year to move it to museum.

Kept big list of problems on the wall, everyone could see where problem areas were. Hardly managed at all. Relied on enthusiasm.

26:00 Documentaiton: couple of published "learned" papers (described SSEM and was first time that term was used rather than Baby). Gave ideas of basic architecture. And some circuit diagrams. One or two photographs which existed. One of which Chris had in files. Of Mark 1 computer. There was a article in Illustrated London News with full centrefold spread on computer ("memory machine").

28:20 but most interesting and useful: we found out about Dai's notebook. Ever since he came on in '48. All the drawings on Kilburn's office went into that notebook; copying the diagrams into notebook was his first task. Many of pages were dated. Earliest Nov. 1948.
Nothing from between June and Dec ("fabulous growth in that time").

With 2-3 pages of text about how everything works.

30:40 talked with Geoff about the big photograph that Chris was using. It was actually a composite of 24 diff images. Alec Robinson took the originals. Then interviewed Alec in Cardiff. One thing to make clear: this project of yours, "I don't want to put any money into it."

33:00 to get circuit diagrams (functional parts), looked at Dai's drawing to see if there was anything that could have been added since June. To see how things had evolved.

34:20 got very plausible idea of circuits, But this doesn't help so much, because you don't know where all the parts went in the rack.

35:30 not impossible to relate each valve to where it went based on photo and circuit diagram (there were only two types of valves). Using this plus a sense of how they might have worked, we could create plausible guess.

36:30 scanned photos, created a scale drawing of how far apart the holes were in the original rack.

37:20 the test was does it work like original. Another test, a "stranger…no a pioneer" comes and looks at it. Tom K was always good at saying that it was "indistinguishable".

38:20 alec came and looked at it carefully. Said it's too clean, not like original at all.

Pioneers are absolutely satisfied.

Writing a paper for Annals of Early Computing.

40:00 most interesting discrepancy: put 6 inch tubes in all CRT places. When Dai came, he said that one rack didn't ring quite true. He thought there was a 12" tube at the bottom. Had to scurry around to buy some. Found a spare box to put it on.

42:00 only thing that damns it in his mind is the wire; wasn't possible to use the kind of wire they used. So he used ordinary hook up wire, Should have used bigger diameter to look like photo.

Other discrepancy: theirs will have been changed a lot; so would look a lot less tidy. Theirs was done very carefully and to plan. This is a pitfall of the goal of authenticity.

43:20 Colour? Pretty constrained. Valves were colour they were; racks just painted battleship. Some wires are red and black twisted.

44:50 pushbotton story. Had a photograph, looked closely at detail, saw pattern of holes, found same pattern in his toolbox, matched it in royal catalogue, found dealer in vintage aircraft parts in Essex, able to read the code number (very faintly). They're from old Spitfires. Found picture on bookshelf, and could see the pattern of holes. They were £30 each.

Daily Mail: "computer built of old fenceposts and a spitfire"

48:30 harder for Christ to get parts than them at the time. Ministry of Supply at Mulvern supported FC and work on first baby. Got parts from Mulvern. Geoff spent so much time at Mulvern looking for parts, that's why he's never in photo.

51:30 excitement: If anyone in the world could do it, it was us, because we really knew this technology. And there was a big event to shoot for. We were constantly getting media attention. Camera crews out to his little cottage. Cooperation from ICL (tools, "like Xmas"), Manchester, Museum. Goodwill and enthusiasm.

Got it done in 3.5 years. Kilburn and Tootill did it in 9mos from scratch.

53:40 'you were most worried about getting CRT to work" why? Because tech is difficult. None of us had worked on that tech before. We were clear that we'd have a mindset to understand non-digital electronics. With CRTs, there is so much deep physics to analogue stuff. It's not easy to transfer from digital to analogue.

Could we still get an old fashioned CRT to work? Couldn't substitute modern tubes because they don't work that way anymore (because of metal screen). So, have they been effected by the time? They are still the weakest part of the machine. We are just completing a new rack of equip to test the CRTs. It's too difficult to test them in machine itself, interferes with demonstrations.

Bought about 14 old tubes, about half work. Should carry us for 50 years, for spares.

Need to test all of them.

57:30 did you feel like you were performing the same actions as before? Chris didn't feel that because he's always done soldering, so it's normal for him.

59:10 in original machine, they would have soldering it very quickly, not the best way that they know now; So they had to train themselves to do it wrong, which was right, in a way. Had to fall back on "how would they have done it?"

1:00 Kilburn had become reclusive. Cliff Jones brought him into project. He got really thrilled by it. Sight: he and Dai with their jackets off, sitting in front of screen, trying to make it work.

END

FACT/ITEM GRANT
JOYCE BOWKER INTERVIEW
26/05/04

Has lived in the same place all her life.

Always worked on flexiwriter at Manchester in the early days.

Later on, she worked with punch cards, but she was "never as good" with punch cards as with tape.

Very easy to press keys; it was an electric keyboard.

Started in 1962 (?) – 1971 (Atlas). Began by being an employee of Ferranti, but stationed at the Uni.

Change to computing service.

Then worked in computer science dept.

Worked in room with about 4 other women. They all informally worked for one person.

She worked for Geoff XXX. In computer service. So might have been working on O/S.
She never had any idea what he was working on. She said she had no interest.

Said she doesn't remember the story about correcting Brooker. But she did learn what common mistakes looked like on the page. She doesn't know how she knew. She says that she couldn't read autocode (but clearly, in some ways, she could). She would often help the students in this way, when she started having to type in their programmes.

Her boss encouraged her to learn programming, but she didn't want to. This is the one thing she said she regrets now.

Hired because had some experience in using an adder. But she was surprised they hired her. Had no qualifications.

She arrived and was in the first week given a report by Frank Sumner to key in.

The job consisted in punching in the text she was given (in handwriting). It would show up as text, and also be punched into a long string of tape. The autocode was all "double dutch" to her.

Very loud machines, but couldn't remember the sound of them.

Didn't seem to have much interaction with the "blokes" as she called them.

Met the first black person she ever met on the job: Goldine. One of the other flexiwriter operators.

Felt the job was prestigious. She said we all "really fancied ourselves". They dressed up; agreed with Ben's suggestion that there might be competition among the women aobut who could look best. Felt it was prestigious to be working at Uni, and moreover, to be working for such an experimental project.

She said work was all about fun; home was serious. She would get serious on the bus going home. Home at that time was to her first husband (married to for 7 years), and eventually, her son. But at work, she had fun with the girls. In summer. They would play on the roof, in winter they would have snowball fights. There seemed to be roof access just outside the room where

they worked. “Play”

She said the atmosphere was very relaxed. It was “all so experimental”. Sometimes there was a lot of work, sometimes not much at all. When she was first there, they would take 2 hour dinners, because no one told them they couldn’t. But soon, they were told to keep it to one hour.

The cleaning lady would “brew” in the mornings, a pot of coffee, and they would all queue up for it. They were scared of the cleaning lady. Joyce said that she was quite messy, would let tape fall around under her desk, and the next morning, the cleaning lady told her off.

ICL people has luncheon vouchers. Sometimes they’d come take the girls to lunch.

MARY ALMOND INTERVIEW
NOTES

30:00 how you got into computer science: my husband worked for Shell, wanted to send him abroad, didn't like being Shell wife, agreed to separate, tried teaching at 2ndary school, iddn't see future. There. One day, read article in Guardian about computing, something that I could do. Applied for jobs in programming. IBM, one or two places unsuccessfully. London Institu of computer science. '60, '61. They offered interview. Day before, phoned and said a much better applicant had come along. But went anyway.

Said she'd be happy to start at bottom and work way up. Prof. Of engineering at queen mary college. Programmer had left, so she worked for a year with him.

Wrote programs for members of that dept. Maths dept wanted to appoint lecturer in computer science, was only applicant, got that.

Had bkgd in physics.

Didn't know about programming when applied. But had done calc in all physic research. Liked boring methodical work.

3:50 had no idea what being a programmer would be like.

Guardian article: 1960, driving past a refinery, Shell.

4:30 perception of computers at the time: this was first had ever heard of computers. Had used hand calcuators for many years; thought it was bigger and better calc.

5:10 took courses to learn how to program at insitute of computer science.

Courses in Mercury autocode and numerical analysis courses.

Had Mercury at Institute. Punching tape (5 track). Had to post it or take it yourself. Wait day or two for it to come back (this is at Queen Mary). Few years later, got online teleprinter. A bit more satisfactory. More or less instant.

What sorts of problems: electrical engineering, solving equations. People would come and ask her: they understood the maths, she would convert into code.

7:07 the people who came to her wouldn't know anything about computers at all.

Lecturing at Q. Mary in programming, but they had no computer.

Sometimes would take tape and watch it being done, quicker that way.

Did go back in evenings when they had online teleprinter.

When teaching, stil lused mercury autocude. Then moved on to ALGOL60, joint authored a book.

Lectured for 5 years.

Only one machine for whole of university, all of the campuses. It was a Mercury, designed in Manc. Replaced by Atlas, but this was after her time.

Fully occupied. But no real demand for another. Lucky to have one.

10:20 didn't know who paid for it.

Users: AT Q. Mary, taking in problems from all over the college and working on them. Had about 3 programmers she managed to do this.

The computer itself was in Gordon Square.

1966 moved to Manc. They were building up the department. Employed three people at once. Employed to each. But also in charge of punch girls.

Working on Altas when arrived; had to learn Atlas autocode. Not very different.; not hard to learn a new language. Never is with computer languages.

ALGOL60 different? They're all pretty similar. Then to Pascal.

15:20 lectured more on numerical analysis and statistics.

Did it follow naturally from physics? Yes, did PhD at Judroll Bank, calculating meteor orbits, with prof. Blackett. So the maths were similar.

Blacket didn't really believe in computers.

Also he worked with Oppenheimer in US on atom bomb.

Worked on rock magnetism with Blackett. Continental drift theories.

19:30 Tom K. interviewed her. Brooker was there. Took her on with idea that she would do all the student admin. Took over from F. Sumner.

Didn't do much research at Manc.

21:00 you could do a degree in computer science by then. First intake was '65. Manc was first in country. Mixture of high power maths and engineering.

Always been bias towards electronics in Manc.

Finished in 1987.

Enjoy working here? Yes.

Retired to look after daughter's children.

Work at Open Univ now.

24:30 What kind of rep did Manc have? It was the only place for getting a degree. She wanted to teach, more than going back into research. Didn't feel eligible and being older. To enter research is a young person's game.

Gave up working with Blackett because she was pregnant; he moved to Imperial in London, and she didn't do with him.

26:26 got offer at Ferranti, but also at the same time, offer from Blackett, so took that.

27:00 who was doing the important work in computing: Ferranti, IBM, can't think of other universities. Had to be reminded of Cambridge. Not aware. Didn't look around at all.

28:00 was there discrimination about you being a woman? Is that why they gave you the admin role? "Possibly."

Did undergrad degree at Manc. Lived at home.

Got married soon after graduated.

Then Judroll Bank. Lived in Didsbury. Cycled out to Winslow. Then they ran a bus, ex-army jeep, taking people out to muddy field.

30:00 then Blackett in London. Gap of 6 years for children. Then Queen Mary.

30:48 being a programmer: how was the work divided up? At Queen Mary, had team of programmers. But at Manc, people always wrote own programs, so had to learn to program here. There were only punch girls at Manc.

How did the users learn to program? Don't know. Other lecturers never sat in on programming lectures.

At Queen Mary: she was the only lecturer. AT end, had appointed more people.

Paper tape girls: were they hard to manage? No. They were well qualified, usually had maths degrees, were men and women. One man, 2-3 girls.

Queen Mary: did lecture to students in other departments: physics, etc.

Main work at Manc was designing computers, OS, Sumner, Derrick, etc. She wasn't involved in that.

Brian Napper appointed same year she was.

35:45 curriculum: what was the goal of the course? Not to design computers, right? To teach them everything. But to do what? Some would go out as programmers and some out as electronics people.

Degrees office keep a record of who goes where, after graduating.

Most would go into industry.

38:40 most of the people she knows went off somewhere into the field; not many left.

How would people know they wanted to do computer science in the first years?

Linda Brackenbury, was in first intake of undergrads.

40:10 mention Dai's thing about digital techniques to her; said Blackett didn't believe in computers. Why? Too slow. Not easy enough to program.

About 20 students in each year. 200 by the time she had left.

Maths, engineering split in dept? Was this noticeable in their orientation towards work? It was more about their inclination than background. Didn't know what Tom's background was, for instance. He became more of an engineer.

46:20 had lots of admin people working for her. Couple of girls.

Professors were in the same place; she was a senior lecturer. Was in staff meetings and etc.

Had joint honours course with other depts., e.g. physics, maths, accounting, psych.

48:22 got own terminal in office later than 70's.

50:00 description of physically working with machines.

Have to learn to type ("but don't type as a professional"). In early days, worked on paper first ("so much more accessible"). Then onto tape. All learned to read the code on the tape. Then moved on to punch cards. Better? No.

If computer was handy, you just fed it in. She used to do her own tape. It came out at same time as you were typing.

Why did you type your own? Preferred it. Would sneak it at weekend and use the lab.

Did you do admin for dept on computer? Made a table of exam results, compuer put them in order of merit. Could change the parameters. Went to faculty meetings with print outs.

TAPE 2
:52, the public eye:

bought a personal computer for her son who had been laid off and was bored. This was before she left. It was an early Apple. He ended up with a degree in computer science.

'66, at that time, was it just a sci tool? How did you explain what you did? No answer.

Frank Sumner advised that she buy an apple.

5:00 are you any better at fixing computers now than Hilary is? No. They both get as frustrated with computers as anyone? Yes. They never had to mend the computer ever, even in the early days.

6:00 the languages you've known: mercury, algol. Atlas autocode, fortran, pascal (for years), Eiffel, ADA, Java. A few machine code pieces. Pascal lasted the longest. Here and at Open Univ. Good language, popular for a long time.

[10:50 still talking about languages, but not very productively]

15:10 never wrote software. Was busy enough without it. But have learned some at Open Univ.