



Chris Little

Interviewed by

Richard Sharpe

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Via Zoom

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Archives of IT

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Welcome to the Archives of Information Technology where we capture the past and inspire the future. It's Wednesday 21st of September 2022. I'm Richard Sharpe and I've been researching and covering and writing about the IT sector since the early 1970s. It's seldom that we have making a contribution to the Archives someone who has been in a prestigious organisation and played a very important part in the development of that organisation for nearly fifty years. So making his contribution today to the Archives is Chris Little of the Met Office, previously the Meteorological Office, which you will know from things like the fishing forecast, etc, etc.

Chris, you were born in the north-east in 1949, I understand, in January?

Yes, that's right.

And your father, what did he do?

He was a metalworker and draughtsman, you know, he was still at school when the Second World War broke out, and then he served his apprenticeship with Head Wrightson's and all those big companies in the north-east of England. And I do remember somebody I met many years later who said my dad could make anything in metal.

And what did your mother do?

Well, for the first few years she looked after me and my two brothers, right? But then she became a, she worked in the Youth Employment Bureau, you know, employing kids and pushing them in the right direction of apprenticeships or university or whatever, right? And it was interesting because after mum's funeral I remember talking to her boss, and she said mum was one of the best office managers she'd ever met. And the thing about dad was, when he finished his apprenticeship towards the end of the war, he entered a competition run by one of the livery companies in London for metalworkers and wireworkers or whatever they're called, and he came either first or second, I forget which, and he won a prize, which was to... which was a holiday, or a trip, for which he had to write a report, and he chose to spend two weeks in Sheffield investigating the steel industry. And of course he told the story that -

that's when he was courting mum - and he used to write letters to mum and the interesting story he told me was in the evening he'd run down the street in Sheffield to catch the last post, and the last post was on the back of a tram. The last tram carried a letterbox and that was the last post. So the world has changed a little bit.

Indeed. Were your parents enthused about education and did they push you?

Oh yes, definitely. They didn't push us, they just took what came, as it were. Got the eleven-plus. There was a choice of two grammar schools in Stockton-on-Tees. One was a kind of a small Church of England, and I remember parents saying, well actually, you stand a better job if you left there, but of course they didn't have a sixth form, you just left with O levels. But I wanted to go to Grangefield, which is the bigger state school, which is where all my friends were going. And of course they had a sixth form. And wasn't particularly... but then by the second year, third year, I was singled out – well, not singled out – half a dozen of us were picked out to be fast streamed so I did my O levels at the age of fifteen, and then went into the sixth form. And so I did my A levels at seventeen, and then in my eighteenth year, that first few months, did the Oxbridge scholarships.

And these were all STEM subjects were they? You'd chosen STEM?

Yes, yeah. Maths and physics. Double maths and physics, in fact.

Why? Why?

Why? Well, because dad was, came from that background. I had a lot of uncles who were plumbers and electricians, or process workers for ICI, so, and really... actually, when I was at secondary school I loved writing stories – sorry, primary school – I loved writing stories and I still like telling stories. But in my first year at secondary school, because I'm lefthanded, my writing's a bit untidy and tends to slope backwards, and I remember my English teacher making me practise writing the alphabet in the back of my English exercise book, and that kind of put me off. And I liked the maths teachers and the science teachers, and I didn't particularly like the history teacher. Once somebody sat in my seat, and I said, 'That's my seat', and I had

to go and sit in somebody's... so I had to go and sit somewhere else, and then we got told off for sitting in the wrong seat and I didn't think it was my fault, so I took against the history teacher as well. So it's kind of fortuitous, but there was that basis in the background. So the kind of books that dad had on the bookshelf were things like Lancelot Hogben's *Citizens for the Science* [*Science for the Citizen*] and *Mathematics for the Million*, it was all part of that New Elizabethan era of, you know, electricity, atomic power, jet aeroplanes. I used to read *The Eagle* and it always had those centre pages with cutaways of the Queen Mary or the Comet aeroplane. And of course, I was a Meccano boy.

[00:05:43]

Right.

My two brothers, who are each a year younger and two years younger than me, Richard, the youngest, he was brought up with Lego, that was his big Christmas present, so it was plastic. I was brought up with Meccano because dad had Meccano – metal – and John unfortunately was in the middle and he had Bayko, which was that toy that was half plastic, half metal.

[both laughing]

And with all this very long, thin metal rods which would definitely fail health and safety nowadays, you know, kids poking their eyes out with them. So... and, to be honest, later on Meccano had all these diagrams just like Lego did, right, they were totally language independent, you had this visual thing. But the original Meccano magazines – not magazines – the instructions were, you know, take a four-and-a-half-inch axle and journal it and two flat trimmings fastened to a two and a half-inch by five-and-a-half-inch flanged plate, right? That's the kind of English I read as a kid, which contributed a lot.

1949 and the early 1950s, we're not talking about Stockton-on-Tees which is today, we are talking about Stockton-on-Tees which is part of an engineering culture...

Yes.

... which had flourished, obviously, during the war and had been very important in terms of engineering and was now under a Labour government being nationalised. Shipbuilding, I believe, was nationalised. Certainly, obviously the coalmining and so on. And it was a thriving, cohesive community, is that right?

Yes. Yes, I think so, because if I look at how my dad did his apprenticeship, I said Head Wrightson's, but in fact, all of the big steel companies had a sort of communal apprenticeship, so you'd spend a year or two at one company, then you'd move on to another one, and then eventually come back to, you know. So my dad worked for a company called AirEx, which made fans and all the materials you need for ducting and things like that, and later... And of course, he was always interested in self-education, he became a night school teacher, and then of course when we went off to university, he went back to university. Which was kind of quite cunning by him really, because two of us were on student grants and Richard was doing his apprenticeship as an electrician – that's my youngest brother – and so when dad went to be a mature student he got quite a big grant and actually he said his drop in salary wasn't that great. And before he finished the course, which was at Huddersfield Polytechnic, now University, they'd offered him a job as a lecturer.

Right. And what was his course in?

Oh, it was just technical education, and becoming a qualified technical teacher, or lecturer. And of course he'd had so much practical experience and of course he rose, became a works manager where he'd be doing all the estimating and things, and then he was headhunted by another local company, called Whaley Welding, where they specialised in quite specialised welding, right. So it was welding titanium or stainless steel or, you know, not just doing simple iron. And in a sense he saw that was a kind of a, not a dead end, but he couldn't see himself rising to be higher than that. He was kind of, you know, he ran the works, and that's why he went to university, or college at the time. And that was a bit stressful and he died of a heart attack a few years later. So never really got to know him, actually.

[00:09:38]

You went to a grammar school because you passed your eleven-plus. Well done.

Yes.

It was your route out. And then you decided – or did you decide, were you pushed – to go to Oxford to study maths.

Yes, yeah. Because, as I said, sort of in the second year, third year, I can't remember which, about half a dozen of us from the – the intake of the grammar school was about a hundred children, so three classes - and they picked out half a dozen of us to fast stream to go to Oxbridge. So I went to Oxford. Where did the others go? Some ended up not getting to Oxbridge, but went to Imperial, went to Cambridge. I remember having a discussion and they thought I probably may not get into Cambridge for maths and they suggested Oxford, and that worked fine. And I ended up being recruited to St Catherine's College by Alan Tayler, who died, oh, I don't know, fifteen years ago. But he founded the Association of Industrial Mathematics, this branching between the academic world and the practical world of actually trying to solve problems. Though quite a lot of his problems that he was trying to solve were actually to do with biochemistry, you know, sort of simulating blood flow and how blood behaved, but that's an aside, right.

How was he as a teacher?

He was a fantastic teacher, he was really good. You could see he was really enthusiastic, he really struggled to explain things to you when you hadn't grasped them. He was, yeah, I owe a lot to Alan. Whereas you got other teachers like- and of course, some of the lecturers I had at university are world famous, right? Michael Atiyah, Graeme Segal, Bryan Birch, they're all... So, for example, Bryan Birch, he gave me, you know, he gave the first lecture I attended at the university, my first course, and I thought, oh, this is really exciting. Then after a while suddenly realised, this is going to carry on, all this new stuff is just going to keep coming and keep coming and keep coming, and there was that kind of, soon realised you've got to slog

away. And of course, Bryan Birch has one of these million pound prizes named after him. The Birch-Swinnerton-Dyer conjecture. So if you can prove it you will win yourself a million dollars from the Clay Mathematics Prize. And so Michael Atiyah was President of the Royal Society, right, and I remember going to his lectures and he's quite a small, lively character, and he'd bounce up and down on stage and he'd really enthuse you and you'd come out and you'd think, I didn't understand a word of that.

[laughs]

Whereas some of the other lecturers were rather tedious and rather dull, but when you came out you understood it and you had a good set of notes, right.

So you'd been taken out of this – I'm not being derogatory when I say this – this metal bashing culture of really making things and making things work and not only that, it's up in the north-east, County Durham, and your accent still gives you away of course, and here you are down in the south, I mean the dreaming spires of Oxford. What was that like as a wrench?

Erm... that's a good question. I actually, I enjoyed it, in the sense that I was enthusiastic, I branched out, I had a grant. Because dad had gone back to college it was a near maximum grant, so I'd never had so much money, so you know, I could afford to buy a Heathkit and build myself a hi-fi outfit for playing heavy rock. I was more Stones than Beatles, really. Obviously you encountered people who went to Eton and Christ Church and, to be honest, I didn't really engage with them very much because what was nice about St Catherine's, because it's a modern college, founded by Alan Bullock, he had a policy of fifty-fifty arts and science, or arts and STEM, and there was also a sort of a, almost a fifty-fifty between the north and the south, right. So a lot... that was the great intellectual shock is, you know, you end up being top of a school, you leave with the best A levels, you're declared as – oh, what was the title, Latin title they gave you for being head of the school? Anyway, they did. And then you'd go to...

Summa cum laude? Was it summa cum laude?

Yeah, summa cum laude, I remember that phrase. And then you go to university and you realise everybody else is summa cum laude, yeah? Everybody, right. And some of them very, very smart, much smarter than I was. So that in a sense was an intellectual shock, that you're not going to become another Einstein. And as Alan Bullock said, make sure you don't get a third.

[00:14:55]

And before you actually went...

But I did, but I really branched out and did lots of things I'd never done before, including sport, right? So at school I was a specky four-eyes, I didn't particularly like sport, but then in the sixth form we were offered the chance to go down to the local rowing club and learn to row, and that was much better because I didn't like the sports teachers, or the original sports teachers, the new sports teacher was fine, who arranged that and so we kind of bunked off school on a Wednesday afternoon and I learned to row which gave me a foot in the door of knowing people in Oxford. And I really enjoyed that rowing, but it took up a lot of time. And yeah, I haven't actually raced for twenty years, really.

And before going up to Oxford, or in your case, down...

Yes, exactly. That's exactly, that's one of the things – I'd forgotten about that – but I could never get used to this idea of 'going up' to Oxford, you know. If I was in London I'd go across to Oxford, and if I was in the north I'd go down. Yes, exactly as you said.

You did have a gap year and you came across your first computer, an English Electric KDF 9.

Yes.

Tell us about that.

And that was... yeah, okay. So in my gap year, it was when I was eighteen, I'd finished my A levels and that first term before Christmas I'd done my Oxbridge scholarship exams and got the results and was, at some point, I can't remember, was told you're going to have a position at St Catherine's. And so I had kind of three-quarters of a year, or two-thirds of a year, and somebody had said – I can't remember how – said they were looking for people with A levels to do a job at the Central Investigation Group of ICI Billingham. And that was headed by a guy called Peter Price who was, I believe, a second wrangler, which is, not summa cum laude, but second highest mathematician in his year at Cambridge. And he wanted me to learn to use the computer and then write an optimiser for multi-dimensional, non-linear optimisation programme, yeah? Basically just kind of work out, you know, work out the profit function, work out which is up, take a step upwards in that direction, work out the profit function again, determine the gradients and work out which is up and keep going up till you get to a maximum and then look around to make sure it's not a saddle point, and that was the idea, right. So I understood the ideas quite well and I took to it like a duck to water, right, learnt to program in about two days. Just given a manual and said, learn this. And it was an autocode.

What year was this?

That would have been 1966.

1966. Wow.

And so it was running an autocode. Later on I kind of looked at autocodes for KDF9 and it didn't seem to be the same as the ones that I'd seen through the Computer Conservation Society, the BCS and the Science Museum. So it may have been ICI's own tweaked one. It was a big machine, it ran 4k of words, partitioned into four partitions, so it ran four programs at once. I never ever saw the machine, because it was on the other side of the River Tees in Wilton. So I used to just go down to the punch room and get, the punch girls would take my coding pad and punch it onto fivefold paper tape. And then the answers came back, you know, with compilation failure or whatever, on telex paper.

That's a very interesting time, Chris, because that year, in fact the year before, in the summer of '65 the Met Office got a KDF 9 computer.

Yes. Yeah. And I didn't know that, didn't know anything about meteorology or hadn't even thought about it. But what was interesting later on when the Met Office was having a clear-out, and including when they had a clear-out twenty years ago before we moved down to Exeter, is I had actually collected up a load of old KDF 9 manuals and Mercury manuals and sent them to an archive in Manchester.

Manchester were running an archive of science and industry and I sent them several boxes of books and the curator said he'd treat me to a meal when I went up there, but that was a long time ago and I've no idea where that archive is now. I really ought to pursue it. But that was kind of... So what was up there were a lot of – we're jumping around a bit here – some of the manuals, the programming instructions, or the process instructions, we'd send out letters to say, okay, the tapes are changing from 9-track to 18-track, this is the timescale on which it's happening. All those kind of things. Or the line printer's bust, we're going to use this other line printer and, you know, all the kind of day-to-day stuff of keeping systems going. So they all went off to an archive somewhere. But by the time I arrived in the Met Office it was 1972 and that had long disappeared. Though there were some interesting things going on, because the competition to supply the IBM was basically shortlisted between IBM and ICL. ICL had come to existence in '69/70. I joined in '72...

'68.

[00:20:29]

'68 was it? Yeah, and they were touting something called the 2900, which I think never existed at the time, but they were kept on the shortlist to stop IBM running away with the price. And what was interesting was what IBM offered, because they offered things like they would – what's the word – tailor one of their tape controllers to take KDF 9 tape drives, so we could migrate our archive. So they'd sent the details and maybe some kit down to the south of France where they had a big lab. I guess that was, wasn't in Sophia Antipolis, it was... somewhere down there, anyway.

Le Gaude?

Yeah. And they kind of produced something that would take KDF 9 tapes, so we could migrate the archive, which of course is a national archive, and it's a real archive in the sense that you expect it to be there in 500 years' time. Anyway, back, just to cover that gap.

Little bit back.

I was going to say, let's cover that little gap. After I left, once I finished my degree...

Where you did not meet a computer.

Where I'd never met a computer, did a bit of numerical analysis, which was a bit tedious. And I was very keen to do good in the world and I wanted to see more of the world, because for my two long vacs, were interesting in themselves. So my first long vac, I'd taken up, as well as rowing, rowing for the college from the first day, I'd taken up caving. One of the reasons I'd taken up caving was another kind of class thing. I'd gone to the Freshers' Fair, all the clubs were there, and I'd think, oh, I quite fancy rock climbing. And I went to the rock climbing society, and they were all a bit snooty, to be honest, and they all said, 'Oh, have you been in the Alps, old chap?' And, 'When are you planning to go next?' And I said, 'Well no, I've never done any rock climbing, I'd just like to learn'. And they were a bit off-putting, really, whereas next door, the caving club just said, 'Oh, you've never been? Oh, we're going next week, d'you want to come?' 'Oh, I haven't got any kit.' 'Oh, we'll lend you a load of stuff, just turn up with your old gear, your oldest clothes, you're going to get wet.' And they took me through my first sump, which was scary. So that first summer I went on the British Universities caving expedition to Romania. And that was interesting, because it was 1968, and while we were there, Czechoslovakia was invaded, by the Russians.

Yeah.

It wasn't a special military operation. And of course that meant we couldn't go home the way we came, which was through Hungary. And of course it was a little bit scary because we heard rumours that there were Bulgarian divisions waiting to invade Romania to see which way Ceaușescu was going to jump. And obviously, Ceaușescu stayed relatively neutral, because he was quite pro-Chinese. So that was an adventure, bit scary. And the second long vac I went overland to India as a mechanic on a bus. So my mechanic background is still there and so I definitely want – and of course I'd also been to France for the first time, with the rowing club, we competed against a French club in Paris. So I'd got my taste for travel. And I was really keen after my degree to go abroad to see the world and do good, as one does when you're naïve and twenty-one, and I became a volunteer. I worked with IVS, which is International Voluntary Service, which there were kind of four volunteer organisations in Britain. VSO was the one everybody's heard of. There was also the International Catholic Committee for International Relations or something, where they tended to send people who were Spanish speakers to South America. There was the United Nations Association, but they wanted people who were highly professionally qualified, like hydrology engineers or power electricians. And IVS tended to do those countries that VSO didn't that were frontline states, like Angola, Mozambique. And I ended up going to Cameroon, which was kind of, was it part of the Commonwealth or the Empire? Well, part of it was, part of it wasn't. Because part of it's French and part of it's English, colonial heritage. I spent two years there and I learnt a lot more than I did at university, though not a lot of maths. [laughs] And I had a motorbike and travelled to Timbuktu and back on my motorbike. So I had that kind of adventurous streak and, though perhaps adventurous streak is not quite the right word because it was maybe naïve, didn't realise how dangerous it was going through [incomp 00:25:24] and, you know, it was not long after the Biafran War, for example. Anyway, came back, decided it would be easier to go back to university than to get a job, because jobs were getting a little bit sticky. I'd written to a few companies, Unilever or whatever like that, and they said, oh, wait till you get back in England. So I did a degree at Nottingham, which I really enjoyed, quantum mechanics and general relativity. And at that point I was chasing Audrey, my wife, who I met in Cameroon, and she was working for Oxfam in Oxford. So my job criteria was within forty miles of Oxford. Not too far to drive on my motorbike – by now I'd got another motorbike. I'd left my previous motorbike in Cameroon, I'd sold

to a Jesuit priest, but that's another story. And so that was my criteria. So I applied to Burroughs, you know, one of the six, you know, competed against IBM. I kind of took against them because they're all very smart and had just the right smartness of suit. You know, IBM was very much white shirts and dark blue suit and sober ties, whereas Burroughs had rather flashy kipper ties, but not too flash and not too kipper, and not flared trousers, but no turn-ups. And I just took against it, kind of just too... yeah. I'm a hands-on kind of person really. And I also applied for a job as a scientific sub-editor at Oxford University Press.

Oh right.

And they were very wise, they said, you know, they gave you a sample bit of text to edit, so identify all the errors. And they said, oh, you can obviously do it, but we recommend that you don't come to us, you'll be bored silly.

Okay.

And the Met Office gave me a job. I just saw this job, they wanted somebody to do programming. I knew a little bit more about computers, because I'd not seen a computer for five years since the KDF 9 days, but I used to go and drink in the evening, as one does as a student, when I was doing my Masters degree, with a guy called Nick Fitzhugh, who was doing a research, he was doing a PhD in machine independent job control languages, or as we call it nowadays, Unix. So, you know, I'd occasionally ask him about what he was doing, and actually that stood me in good stead for when I had the job interview at the Met Office. The Met Office asked me the sort of questions about, you know, Assembler, first, second, third generation languages and of course I could answer all of that, and they gave me a job.

And you started on 5th November 1973.

1973, yes, that's right. It took me a little bit longer to finish off my thesis at Nottingham. So I started a little bit late and I just missed that kind of, the normal intake in September/October.

1972, 1973, very, very interesting years for the IT industry. In 1972 the C programming language was devised, in 1973 we've got ethernet from Xerox digital equipment and Intel. We've got 16-bit microprocessor from National Semiconductor, and I think for the longer-term trend we've got the emergence of the relational database.

Yes.

So really very interesting, things are really bubbling in IT at that period and you join...

Yeah, and I think...

Go on.

I was going to say, some of the things that were bubbling on that you didn't mention were pen plotters and graphics.

Go on.

[00:29:29]

So when IBM won the contract in '70/71 to place a KDF 9, because they were a bit worried that ICL would get the contract they kept piling things into the contract and said, oh, we'll add this and we'll add this for the same price. So they added a load of Calcomp pen plotters which were superb, right, they ran at 6G, right, so when they were plotting you couldn't see the pens, they were moving that fast. And they plotted A0 size, you know, square metre. And they also supplied a microphone device that plotted on 35-millimetre microfilm. So basically the film was exposed in front of a cathode ray tube, which was a, wasn't a storage screen, but it was a vector screen. Not a raster screen, because then vectors and rasters were completely different. Rasters, they came from Ramtek and image processing. The vectors came out of a Techtronics world where you draw the graphics with the cathode ray. And so they just exposed the camera to the things being drawn and it would draw a 16,000 by

16,000 equivalent resolution in two seconds. So we were producing, so the Met Office was producing 100,000 charts a day, most of which weren't looked at, but you didn't know which ones you looked at, needed to look at until the weather was sorting itself out. And I do remember, the Met Office had stuck away in the systems lab an old pen plotter which had obviously come sometime during the life of the KDF 9, and I think it was built by the British Technology Corporation, or whatever it was called, in the late sixties, and the idea of this was to speed up engineering drawing. One of the bottlenecks of engineering was doing the drawing and draughting, and all these people who'd qualified as draughtspeople, and speeding up that process to speed up the process by which the white heat of technology would start churning out new technology. And so the Met Office had one and it was useless for meteorology because it would draw lots of straight lines reasonably fast. Meteorology doesn't want straight lines, it wants wiggly lines, and it was abysmally slow, whereas the Calcomp devices were much, much faster. And of course that old device was a flatbed, so you had two axes and the pen was moved on two different axes, whereas the Calcomp device, it was a belt plotter, so the pen moved backwards and forwards and the paper moved up and down.

Yes.

Yeah, so just that simple choice of, engineering choice, really made the difference.

I, my first job as a computer operator was with an ICT 19... oh, 1902A, I think it was called.

Yeah. Okay, yeah.

And it was in EMI Electronics research and development, and we had Calcomp plotters, which were excellent, but I had to change the inks in them. Anyway.

Yes.

'71.

Did you, I was going to say, did you go through that thing about only using red and black ink?

Ah no, we had green as well.

Ah well, green – well – red and black are archival, they will last 500 years at least.

Oh right.

If they're the right black inks and green, the only one that, only green ink that is archival, will last hundreds of years, is based on arsenic. It's actually very hard to get. And of course that's the essence of the plot of *Name of the Rose*.

I think that this was the engineers and they would look at it and they would store it away, but had no historical interest in it, they didn't anyway. And this was an IBM 360/195?

Yes, that's right.

That IBM installed.

Yeah. And it was the biggest machine, when it arrived it was the biggest machine in Europe.

Right.

Or biggest and fastest machine. But then later on, I think just after I arrived in '73, sometime in '74, I think a German research lab bought a slightly bigger one. It just had more memory and more disks.

But you saying that shows that there is a consistent pattern here of the Met Office demanding more and more and more computing.

Yes.

And often being really at the forefront of applying the latest technologies, including CDCs later on, Cray machines, etc.

Yes, yeah, yeah. And that's driven by the mathematics of meteorology. You're trying to solve simultaneous, non-linear, partial differential equations in time unknown, basically, which is hard, right? And you approximate it by discretizing it by doing things on a grid, you know, they're not analytic solutions in any sense, it's on a grid. But the closer, the finer the grid is, the more closely it approximates the continuous solutions that the atmosphere behaves by. So you know that if you've got a bigger computer, the weather forecast will be better. And that's a mathematical kind of certainty, as it were.

[00:34:49]

But as far as I can see from the documentation I've seen, in 1952 the grids were, the grid size was 260 kilometres.

Yes.

In 1973...

But that was not global, that was just for North America.

Yeah. In 1973, by the time you join, it was down to a hundred kilometres.

Yes. But that was only northern hemisphere.

For the northern hemisphere.

That was northern, yes, it's approximate because it's northern hemisphere. They were running a model down to fifteen degrees north, it's not quite even hemispheric.

By '91 it's down to ninety kilometres.

Yes.

By 2017 it's down to ten kilometres, I understand.

Yes, and we're now pushing seven.

And you can even have a sub-grid of one point five kilometres. Are those numbers right?

Yes. Apart from the fact that in research now people are studying down to 200 metre resolution for urban areas. But in fact when the Olympics were on in 2012 we did run a third of a kilometre model for the Dorset coast. That was relatively easy to do because it was at sea, for the yachting, and there was not much aerography, so the sea is relatively flat, so the numerical problems you get with instabilities in the equations weren't there. But as soon as you get to that kind of resolution, whether you have a tree or not in a valley affects the forecast. You know, it's that sensitive, so in that sense it really is chaotic.

Yeah. Now can I press on with the more theoretical parts of this, if you don't mind, and then get back to you. Because – so that's grid size, which is very, very important. But of course...

And in the vertical as well, and time. It's not just horizontal.

Yeah. Now, you take then readings at different levels, so you've got different levels in the grid?

Yeah.

You do?

So in the sixties on the KDF 9 it was a three-level model. The very first models were run on ENIAC by John von Neumann and co, it was kind of a single-level model.

Then it went to three levels in the sixties. At the beginning of the seventies on the IBM mainframe it's a ten-level model.

Right.

Because basically, to a first approximation the atmosphere's in sort of two halves, the top and the bottom, doing opposite things, and then you just need to then, to get the forecast to work you just need to resolve that. But you also need to reduce the time step, right, so as you increase, decrease the horizontal resolution, the vertical resolution has to decrease and the time step has to decrease because the mathematical equations otherwise become unbalanced. It's called a Courant-Lewy-Friedrichs [Courant-Friedrichs-Lewy] condition for discretisation of equations. And nowadays we are kind of doing the order of 200 [incomp] in the vertical, and the time steps have come down from, you know, an hour, half an hour, down to minutes, less than a minute. To be honest, I'm not sure what the time step is now.

Okay, that's two aspects of it. Another one is, you've got to actually capture this data, yeah?

Yeah.

And so it's capturing the right type of data, which is, which we probably now know will be windspeed, temperature, you know, biometers, etc, etc, yes?

Yeah. Yes.

And the accuracy of that of course is very important, but another level as well, completely above that, it seems to me, is what model are you working to? So you have to have some form of model to actually make all this thing together. Am I right there?

Yes, yes. So in the sense that the early attempts were on what are called the primitive equations, which were written down in the 1890s in Norway, and as I said, they were just a multidimensional, simultaneous, non-linear differential equations in five unknowns, which are pressure, temperature, windspeed, humidity. But then as soon

as you start saying well, I need to do other things, I need to have some physics in there, you know, because the first models were dry, and then you'd say, oh, now I need to put moisture in, when does it rain, when does it not rain. And of course, moisture in the atmosphere affects how quickly it warms or cools, and then of course you've got the latent heat of the condensation and all that kind of stuff. So the model gets more and more complicated. And so you have this extra step, so you may observe something like you've measured infrared radiation coming out of the top of the atmosphere from a satellite, and because you know the relative transparency of the atmosphere to that particular wavelength of infrared, you know that there's a weighting function that says, well actually, this represents the atmosphere between about 500 and 350 hectopascals, yeah, millibars if you want to call it that. Which is kind of quite approximate really. But you then ran a process that turned that radiance that you measured at the top of the atmosphere into an approximate temperature, which you then fed into the model that ran on the primitive equations, but we don't do that any more. What we do is we actually have radiance in the model, so you just take out the radiance, so those extra equations for converting radiance into a pseudo-temperature are used in the model directly, and the radiance just goes straight in the model. And the experiments that are going on now are taking radar reflectivity and putting them in the model. So rather than just passing, saying oh, there's a radar image and therefore we interpret, that blue square is heavy rain and that red square is even heavier rain, and then putting in the rain, pseudo-rainfall, we're actually putting in the radar reflectivity in the set of equations, so the equations are becoming extremely complicated.

Right.

[00:41:11]

But, because not only do you have to kind of halve the horizontal resolution to get better forecast and double the vertical resolution in time, you then, as you go to finer and finer grids you have to put more and more physics in.

Okay.

So when you've got a grid of a hundred kilometres, you've got 10,000 square kilometre square with a load of thunderstorms in it. So you just approximate them by saying well, approximately it's ten per cent thunderstorms, ninety per cent not thunderstorms. So that's not at all physically realistic, but it works. But as you get down to one kilometre, in a one-kilometre square you have one thunderstorm, or no thunderstorm. And then you start simulating the thunderstorm much more explicitly. And of course all those processes that go on in clouds, like ice, and ice changing its phase between different crystalline forms, because ice low down in the atmosphere and ice high up are different, you know, because the ice at minus forty or minus fifty or minus sixty is different from ice at minus five Celsius. So, you know, there's lots and lots of physics. And that's where a lot of science is now going. And then the other strand of the science that you have to push, as well as kind of understanding all the physical processes and getting equations and being able to predict them, or predict their interaction, because you also need to get the energy cascade, because you've got moisture evaporating from the ocean, which brings heat out of the ocean, but it also brings momentum into the atmosphere. You know, so you've got all these fluxes of different things and it's extremely complex. But the other thing that I was trying to grasp at is – oh, gone, completely lost it. [laughs]

It's alright. So, you've spent a month at the Holly Spring hostel where this was – not all of this, because of course you've been through a great history of it - where some of the fundamentals of this were revealed to you.

Yes.

In 1973.

Yeah. Well actually, it was really '74 because...

'74.

Oh yeah. Yeah, so '73 I was in the hostel till I found somewhere to live, which I shared with some other people same age as me. There were a lot of people from the

Met Office I could have shared with and we kind of chose to not live in the same house, to use different houses because then we'd know twice as many people, right?

[laughs] And very soon after this you were given a grey desk, a pencil, a notebook, an eraser and an IBM Fortran coding pad, and you were introduced to Fortran.

Yes, that's right.

[00:44:12]

How did you take to Fortran?

It was fine because my first program worked. I was given a batch of cards, so the, for those who love IBM JCL, the job card was orange, the JCL cards were white and the Fortran cards were either green or yellow and the data cards were beige, and it was kind of quite colourful. And my boss, Ann, Ann Jackson, she was a sort of senior programmer, as it were, she just said, oh well, your first day, start reading the manual and see if you can write a program to print out the first hundred or thousand prime numbers. Which of course I did, I wrote a program, and she put the appropriate JCL round and she took me down to where the card readers were and showed me how to punch cards and how to feed cards into the card reader, and then later that day the output came back on standard fanfold paper and Ann was kind of quite surprised because she said, oh, here's the output come back. Because in those days you didn't always go down to the punch room or the output desk, there was an assistant whose job was to do that. It was a much more kind of hierarchical organisation than it is now. And Ann said, oh, let's see where you've failed. And of course she was rather shocked that the program had worked first time. And that was a bit of a, I was quite pleased when my next job failed, because it was a bit of a reputation to say, you know, I can't maintain that.

Fortran was my first programming language. It still has a special place in my heart. Given what it was, given that it was formulated in the middle 1950s, wasn't it, it really is quite a neat piece of programming, I think.

Yes, yeah. And I still tend to put, my integer variables begin with IJKLM and N, and the real variables with all the other letters, and I used to joke with friends about, oh, I can write Fortran in any language you want, write in C++ if you want.

[laughs] Oh, that is true. One often actually writes in other languages exactly how you had learnt your first language.

Yes, yeah. But what was really interesting is when I arrived in the Met Office in '73 and then '74, the forecast program, the model of the atmosphere was written in Assembler and the Assembler itself had been modified by the Met Office to get performance, right? So they thought that the subroutine handling, you know, where you're sort of saving the registers and then moving into an Assembler subroutine and then restoring the registers was much too slow, so we kind of tweaked that so it ran much, much faster. It required a bit more discipline from the programmers and when things went wrong it was much harder to work your way through the dump. But we tweaked the Assembler to make it run faster. The other thing we discovered on the IBM 195 – which this is another aside – was if you got your loops down to less than 32 bytes, it ran like a bat out of hell, because it stopped doing 'fetch' instructions and there was a very small buffer and it did everything from there and it was extremely fast. The engineers couldn't believe that we were kind of getting 99.9% CPU utilisation. They're thinking, something's wrong. Said, no, no, it's just running, it's just running as it does. How do you make it run that fast? But the other thing that was interesting that was going on, we also tweaked the channel programs, right. So IBM had all these channels which are subsidiary processors to handle the IO between memory and the devices and they didn't run fast enough either, so we tweaked those. I didn't do that tweaking, Rex Gibson was one of the people that did that – John Gibson. And he's still alive, and I'll mention him later actually. And, but what was interesting is IBM had come out with their H compiler. I guess they'd been through A, B, C, D or whatever. An H compiler is they'd put some optimisation in and when you wrote something in that straightforward H compiler Fortran it was as good as, but not much better than, the Assembler, the good Assembler. So it was starting to beat Assembler. And then when you got to complicated programs- so if you're doing the big matrix multiplications that you would get in the model, the atmospheric model, you could still beat the compiler, but with the data assimilation where you'd taken the

observations – and these are messy things from the real world with errors in them – and one of the things that really decides whether you’re going to get a good forecast or not is whether you’ve chucked out the bad observations, right? If you get bad observations it screws up the forecast. And actually, the error checking of real world observations, whether they’re from ships or aeroplanes or ground stations or radiosondes – no satellites at the time, they were just coming in later – that really can screw up your forecast. And there are interesting examples, so one of the first papers I wrote inside the Office was just an internal technical note and it was a forecast had gone wrong, slightly wrong, and a storm came up the Channel and it went the slightly different direction from which we’d forecast. And so I investigated it and I put it down to one wind observation from a weather ship in the south-west approaches. If you left that weather ship in, it gave the wrong forecast, if you took it out, it gave a good forecast. Six hours later, it reversed. If you left it in you got a good forecast, and you took it out, you got a bad forecast. So it was literally down to one observation of winds, none of the other parameters that came from the ship, right, there’s a lot of things, and so that really highlights that chaotic approach. Yeah, was it John von Neumann? It may not have been John von Neumann, don’t take that for word, you know, a butterfly flaps its wings in the Amazon and that alters the weather in Europe. Personally I’ve always preferred the much better metaphor, is forecaster opens his mouth and alters the weather forecast.

[00:50:48]

So anyway, the H compiler, so writing the data assimilation program, which is what I was doing for the first few years at the Met Office, was much more complicated, lots of IF tests and real world, it’s not big matrix multiplications. Well, there are some, but not a lot, it’s a lot of ad hoc things. And the H compiler was definitely better than Assembler. And then the next generation of model was written in Fortran.

So you moved away as well in about three, four years later from the IBM machine, you got a CDC 660.

Ah, yes, but there’s an interlude there.

Go on.

So once I'd been in the Office for a few years, a job came up at the European Weather Centre which had just been established. That was in Bracknell and then it moved to Reading and it's still in Reading. And the ECMWF, European Centre for Medium Range Weather Forecasts, was a pan-European organisation set up by all the national met services in Europe – and that's not just European Union – so you've got Norway and Iceland and Turkey, and Cyprus are members, for example, to do medium range weather forecasts, to do weather forecasts for a week. Now, that's kind of, you can't do a one-week weather forecast without actually doing a very good six-hour or twelve-hour forecast, but they're taking a day to do that forecast, so actually that's not useful for a lot of customers. So we can give you a really good forecast for twenty-four hours, but actually, it arrives in twenty-four hours. Which is where of course the ENIAC was, right? The ENIAC took twenty-four hours to do a twenty-four hour forecast. And of course it took three months to program the ENIAC to do a forecast. So ECMWF was tasked with doing one-week weather forecasts, nobody had ever done that before. There was, of course you're going across the life cycle of a depression. A depression doesn't last, it only lasts three or four days and then it dies and another depression appears somewhere, right? So you're sort of going across the generations of the meteorological systems. So it was not at all clear that the science would enable that. So I went to work for them for three years on secondment, so I could come back to my old job. And they had, at the time they hadn't got an office, their offices were above the Mac Fisheries supermarket and I was in an office near Bracknell railway station with a CDC 6600, which is the first computer they got to do testing. And again, I was involved in the data assimilation program, with a guy called Andrew Lorenc, who's just retired recently, and the head of the assimilation group was a Canadian, Ian Rutherford, who moved out of meteorology much later. Went in the Canadian government. And we were using a new technique for doing the data assimilation, and that started on a CDC 6600, which was fun, because it was in the office next to mine, so I could go next door, it was all very open and I could see my program running and I could talk to the operators and we could run Moonlanding program. Because the 6600 had two big circular Techtronics storage screens, which were very, very high resolution, and of course you could also run the Moonlander program, which was one of the first games that was programmed on it. And then only

later, after about a year, was the contract won by Cray 1, by Cray, to supply a Cray 1. And then I went over several times to Minneapolis to use the Cray, and I used the Cray 1, serial number one, which was slightly different from the next couple which went off to the spooks, and I forget which number, I think it was probably four or five went to the National Centre for Atmospheric Research, and by the time ECMWF got its Cray I think it was probably up to serial number nine, seven or nine, I can't remember. What was different about the Cray serial number one was, as it was the first one, it was a sort of first working prototype, it didn't have parity checking on the memory. There was no SECDED, single error correction, double error parity checking on the memory, so if a cosmic ray went through you may get a wrong result. And it was also six inches shorter, the whole machine, because it didn't have, you know, there was a few boards missing at the top.

[00:55:31]

So that, so I used the Cray and then when I- and quite a lot of people had gone on secondment to ECMWF because we were on European salaries, which was very nice, and half a dozen people had gone before me: John Gibson, Dave Burrige, and a couple of other names. And I was the first one to be forced back because suddenly the Met Office and all the other European met services suddenly realised their staff were not going to come back, they're going to stay on the European salary, tax free, basically doubled my salary really. So I was forced back and I was basically told to apply for my own job at the European Weather Centre and I would not be given it. So I went back to my old job and then got involved in the replacement of the IBM mainframe with the next supercomputer, and of course that was won by CDC. And the reason they won it rather than Cray, because by then Cray was working on the Cray 2, which was the fish tank machine. So the Cray 1 was very special because it was a big aluminium frame, and the frame was hollow, and you pumped freon through the frame and then there was a good kind of thermal contact between all the copper boards that the, seventy-two chips on either side, and they were clamped into the aluminium frame, and that's how the cooling was done. So the cooling problem – that's why Cray was so good, he was a really good engineer, it's not just for computing. And the other thing that was interesting, which is relevant to later on in the stories is of course when he left CDC, because they wouldn't let him build his

8600 which was reputed to be spherical, you know, because of the speed of light problem, he took a guy called Nelson with him who was one of CDC's top software designers and he wrote the compilers and the operating system, and so the Cray software was very good. And anyway, so the reason CDC won the contract with the Met Office is of course is they'd taken the design basically of the Cray vector pipes where you're doing registers with sixty-four numbers and then you feed them with another sixty-four numbers into a sixty-four number register, so you get this pipeline speed because all the units are segmented. So having started doing an addition, six steps later, six clock ticks later, you get the result. You know, you've done the shift and the add [and?] and all that kind of stuff. But then, because they're all lined up in a pipeline and they're all stepping through the segmented pipeline, every clock cycle you then get another result. And that's how the vector register worked. Now, Cray enhanced that design – sorry – CDC enhanced that design so they could actually, rather than just do it via registers, you could do it from memory. So you could feed the function units from memory and back into memory. So you didn't have the 64-bit, 64-word hiatus where you then had to reload the registers. So you got a bit more speed that way, but they also discovered that – and this was some work that was done at the European Weather Centre by a guy called Tony Hollingsworth – he looked at the mathematics of running numerical models and came to the conclusion that you did not need 64-bit precision, which is what the Cray had, 32-bit precision, generally speaking, was good enough for solving equations if you do your numerical analysis right. Some of the inner products in the matrix multiplications would have to be in 64-bit, but generally, 32-bit is good enough precision. And of course, we'd been running numerical model on the IBM mainframe which was 32-bit, for several years and they worked fine, right. So CDC set up their function units so that they either multiply 64-bit numbers together, or, pairs of 32-bit numbers, so you got double the speed, so it immediately ran without the problem of loading and registers and feeding from memory, you're automatically doubling the speed. And they probably won, and that's why they won the contract.

[00:59:48]

A Cyber, sorry, a CDC Cyber 205?

Yeah.

And you were still programming it in Fortran?

Yes, though it wasn't really Fortran because, as I said, Dick Nelson had left and they were kind of struggling with their software, I think, and basically they had all these machine calls to these, if you did it in 64-bit arithmetic the Fortran compiler just looked, the Fortran just looked like they knew their Fortran. But if you wanted to use what they called 'half precision', you had to use what were called Q8 calls. Basically they just took the machine instruction and embedded it as a subroutine. So you're writing Assembler embedded in the Fortran.

Right. You then become a senior programmer.

Yeah.

Now, Chris, have you ever been a manager?

Yes. Yeah, the most people I've managed is fifty-five people in the Met Office, and...

What is the Chris Little approach to management?

Oh, that's a good question. Excellence, I think. Let people do what they're good at, try and – actually, I suppose it is actually by demonstration, right? So, expect the same high standards of them that I apply to myself, which is not necessarily very good management. I'm a rubbish maths teacher.

Okay.

Yeah. What do you mean, it's not obvious?

Are you impatient with people who are not as clever as you are?

No, I don't think so. No, no.

Okay.

No. I think I'm kind to people, though I can actually take hard decisions. I'll tell you a couple of stories.

Good.

Which, you know, we're gobbling up the time here. But when I became the... responsible for program techniques I had three teams working for me. One was the program techniques team, which they advised people on how to use tapes and how to use disks and how to use memory and train them in Fortran, and training people in Fortran is non-trivial because when you say, oh, let's do a flow diagram, how would you do a flow diagram for putting your socks on, right? Socks and shoes on in the morning, so that's kind of real beginners' stuff. And of course people just could not see the problem with putting on shoes before putting on their socks, right, and you think, oh dear, oh dear. And we also had the database team. So those were the three teams: database, programming techniques and computer graphics. Now, in the computer graphics team, it was basic pen plotting team, it's not computer graphics, it's pen plotting. So using the inks, making sure the pens don't rip up the paper. And the team were interesting because the guy, Tony, who ran it, he devoted the last part of his career to understanding these programs we used for drawing contour packages, for doing the observation plots, which are kind of quite sophisticated, right? The weather symbols, meteorologists around the world, whether in Moscow, Beijing or Brasilia or Washington and Pretoria, all use the same symbols. So I could walk into the forecast office in Beijing, pick up a weather map and understand it and use it. Providing you understand the Chinese for high and low, but that's pretty easy, actually. Chinese symbols for high and low are self-evident in the sense they've got a horizontal line at the top for high and a horizontal line at the bottom for low, right? So just like H and L, right, which is what we use. So he had this suite of software, 50,000 odd lines of Fortran, that did all the specialised plotting for meteorology. Contour charts, and as I said, we were doing one chart every two seconds on the microphone, take a bit longer on... And of course then you have to spend half an hour because that short length of film then gets put through an automatic development

process, which is cut short. If you wanted archive you would then develop them, fully develop them and then it, you know, it becomes a proper silver iodide film which is archival. Anyway, so Tony was responsible for that kind of programming and there was a young assistant working for him, she was eighteen or nineteen, I think she had O levels but not A levels, and she was quite good at her job and she, you know, did a little bit of programming and she was good at it, but she was very ill. You know, she used to be very ill and not turn up and we just put it down to period problems and later on we were thinking, oh, maybe she's got a bit of a self-image problem, bit worried about, she was having boyfriend problems or whatever. And anyway – and she'd used up her maximum, you know, she'd exceeded the limits for illness in a year, or in a couple of years. So paying attention to it in that sense, but not punitively in any way, right? We just said, yeah well, we were really worried. Because the civil service is a good employer, right, there's no doubt about it, they do employ... Anyway, one day she didn't turn up and we were kind of, totally unexpected and we were really concerned. So I sent Adrian, a team member, round to where she lived to find out if she's okay. And he sort of knocked on the door and no reply and knocked a few times, and he was a little bit worried. And a neighbour stuck her head out the window and he said, 'Where is she?' And she said, 'Oh, she's gone to work'. And he kind of was sort of a bit taken aback and said, 'Where's she gone to work?' And said, 'Oh, she's a barmaid in the Market Inn'. So I'm afraid we fired her. [laughs]

[01:06:00]

Now, you have a great technical knowledge already shown to us in this interview so far and you could earn a lot more money by not working for nearly fifty years in the Met Office. Why do you stay in the Met Office?

It's intellectually interesting. Simple as that, I think. I've got a lazy streak perhaps, I don't know. I was poached, people tried to poach me once or twice. So Cray did, for example, Cray wanted to poach me. But actually, may not surprise you, but Cray didn't pay over the odds now.

Really?

No, no, because they had the status, right? They didn't have to. So...

You would have got shares though. You would have got shares.

Yes, that's right. Yeah, yeah. But actually, the job they'd offered me, they actually wanted somebody who would take responsibility for selling Crays, or technical support of selling Crays into India and China, and also benchmarking meteorological, you know, because they wanted to sell into the Chinese meteorological administration and the Indian met department, and things like that. And I just thought the responsibility and the amount of work for the amount of money wasn't worth it, to be honest. And because in a sense I've had four or five careers inside the Met Office, right? So my first career was data assimilation and did the maths change, so when I first started in the seventies I was actually using the maths I was taught at my Masters degree in Nottingham. And when I went back to see one of my lecturers and I told him, oh, I was using high-powered polar numerals, etc, etc, to do simultaneous fitting of lots of observations, he just said, you're in the real world using the mathematics I taught you at university, he was over the moon. And then when I went to ECMWF it was a completely different mathematical technique, it was optimum interpolation. And then when I came back to use the CDC 205, doing my third operational data assimilation program, we used a third technique which was variational analysis. So that was intellectually very interesting, and I still had this inkling that maybe I'll be a scientist and I'll, you know, it's one of the things that sort of bugged me about leaving ECMWF, I want to be a scientist, I want to publish a paper, and having written all this code, now I'd like to do some science about how you assimilate those observations and the stuff about, you know, the impact of satellite observations, you know, running the forecast with and without observations, satellite. I may put in another aside in there, because satellite people think they're the bee's knees, and it's true to a certain extent now, but when satellite data first came out it was basically rubbish. Covered the whole globe, but it was actually very low-quality data, because you're measuring radiance coming out the top of the atmosphere, which you're then approximating to a temperature somewhere further down, which may be below cloud. So in that sense there was a big, metaphorically there was a big red button that the forecasters had which they could press and that would remove all satellite data from the forecast. And generally, in the northern hemisphere, it got better. In the southern hemisphere it

deteriorated. So the satellite data was improving the forecast in the southern hemisphere but making it worse in the northern hemisphere because of the errors. But it's improved since then, a lot. Whereas now it's very contingent on satellite data, and you could take out some of the ground data which is used for sort of ground truth for validating the satellite data as well. So, where did... oh, I've lost the thread and which was the main tack there.

That's alright. Why you stayed.

[01:09:58]

Why did I stay? Yes, that's why did I stay. So that was science and in a sense I was actually, when I was doing the third data assimilation on the Cyber 205 I was actually in NWP, Numerical Weather Prediction research, right, and my boss was a director of research. And at that point – and I'd still inklings, oh, maybe I'll finish with it – but I was good at programming, there's no doubt about it, but I still had an inkling to be a scientist and then, you know, the boss's boss said, to be honest, Chris, you haven't published any papers and you're really good at what you do and, to be honest, you're not going to be a scientist, we think your career will be much better off back on the IT side, in operations. And to be honest, I agreed with them. And one of the things that fed into that was my director of research had just said, oh Chris, computer graphics seem to be taking off, can you go and investigate computer graphics because we've got pen plotters, but maybe we should be doing things on screen. So when the IBM 360/195 arrived, there were a couple of graphics screens, but you had to stop the whole mainframe to do anything and you had to use a light pen and they were vector screens and the drawing was very crude, and to be honest, it was no benefit, right, so they weren't used. And of course then, as I said, you had these two different themes in computer graphics, it was the vector screens coming out of radar and Techtronics, with the storage tubes, where you're drawing very high resolution, the cathode ray tube is moving around all over the place, and then the Ramtek kind of image processing where the cathode ray tube is constrained to a raster scan, and then you're doing colour. Whereas of course the storage tube and the vector tubes are monochrome. Though Techtronics did produce a two-colour storage tube, which was a slightly bizarre sidewater of the main flow of technology. So I went away, I looked

at what was available and said, oh well, we're starting to get this convergence of raster and vector and that makes it useful for meteorology, because what we want to do is display radar data or satellite data, overlay it with the observations, overlay it with the contour charts, underlay it with the map of the coastline, and if you could do it with, say, 8-bit planes you could just do it in 8-bit planes. Whereas before then, the forecasters had a radar screen with bits of acetate taped on it showing the coastline and then you have another device showing the latest images that had come down from a satellite. And then they'd had all their paper charts on the light table. And of course you put charts on top of each other on top of a light table, shine the light underneath, and then you could look at the relationship between the upper flow and the lower flow. And that is a good forecasting tool and it's comparable to doing it on the computer. And so I produced a report and said, well actually, for about £30,000 – so this must have been early eighties, late '79/80, something like that – for about £30,000 you could get a minicomputer and you'd hook up one of these latest new graphics devices that was both raster and vector and possibly get two seats. Well, definitely get one seat, because you definitely, 1,024 resolution by 1,024 and you definitely need 8-bit planes, you know, to do anything useful, and it would cost about 30,000 quid. And so the director mulled this over, and he looked quite uncomfortable. I said, 'Is there a problem?' He said, 'Yeah, it's the budget. I did tell you there was a bit of money to spend in the budget.' And I said, 'Well, how much is it?' And he said, '3,000'. So that eventually... so the directorate then started putting money in and it turned into a project called the Powerful Interactive Graphics System – PIGS. And it didn't fly, because as soon as the word got around all the other principal scientific officers who were doing nowcasting research or radar research all jumped on and said, oh, I want a piece of this, I want a piece of this, I want to be in on this, this is, yeah, this is where it's at, right? And it grew and grew and grew and it started turning out to be about a third of a million quid. And at that point Roger Wiley, who was the director of IT, killed the whole thing and bought another mainframe.

[01:14:45]

Now, we've got to move on. Y2K, how difficult was that?

Erm, in some ways it was very straightforward, because before Y2K I'd got involved in designing data formats for the World Met Organisation and we'd designed a couple of binary formats, because there was a lot of telex based, telegram-based character codes that had been around for fifty years, and that's how the data was transmitted. And just saying, no, no, we've got computer-to-computer links, why are we using character codes, you know, why are we using kind of 7-bit ASCII, you know, to transmit over a telex, right? Okay, some of it's automated but it's still slow. And obviously it's the only way you got data out of Burkina Faso, who remained on a 300-board link, but that's how the system worked. And we said we need some binary formats, and we invented GRIB, which stood for gridded binary data. And we also invented BUFR, which is Binary Universal Format for Representation data, which did all the observation data, it was a very flexible data format, but it was binary. Hinged around kind of 16-bit structure, or 7-bit structure. And when we designed GRIB and BUFR we said, oh, we need a header and of course we were still thinking in terms of characters, even though it was binary, the data. So the header was in characters and the data was in binary. And we then said, well, traditionally, the observations that were sent around the world every day on the hour from every met service to every other met service didn't bother to say what month it was or what year it was, it just said date and month, and hour of the day, and that was enough. Because the context is, this is daily observations, right? But of course then you have to do something when you start archiving it. So we just kind of carried on with that and we said, oh well, those two bytes there represent the day, those two bytes represent the month, and oh, we need two bytes for the year of the century and two bytes for the century. And we sort of, we did that and then moved on to all the stuff about compression, run linking coding and, you know, which way do we scan the data and do we allow different scannings and [incomp] scanning to, you know, because the run linking coding will become much more efficient. All that kind of stuff. And then the Americans were first out the door with an implementation and the programmer that they'd contracted had written a spec and said, ah, year of the century, as it were, the century count, and he put in there '20', this is 1900s. 1980, 1990. 1995, right, or whatever. And he said, oh well, it's twentieth century so he put in '20', not 19.

[laughs]

And we all met at a meeting in Geneva and when we found that out and we all went through the roof, and then at that point, John Stackpole, who was the chair of the expert team and American, just said, well, we've programmed it and the contract's finished and we can't get another contract to change it, and we lived with it. So when Y2K came, it wasn't a problem.

[laughs]

Because the century didn't change till a year later.

Two years after that...

Though in fact, having said that, there was lots of other software that did need change and I think there was only one product, I think, that fell foul, and that was a fax chart where we were generating – because we also go back to the days of wet fax before T4 fax, you know, these big machines that use wet chemicals to, you know, and you put them on an analogue line. And we used to program and put the date and time in big letters in the corner of the chart, and we'd forgotten about that one that had gone to the navy and it just started saying completely the wrong date and time. But the navy spotted it and it wasn't a problem, but everything else got changed. But a lot of programs had to be changed. And it just worked and I remember just after it all happened and it kind of worked and there wasn't any disaster in the Met Office, meeting one of the directors coming springing up the stairs, and he was over the moon that it had all worked. And I just remember being absolutely knackered. Yeah, he was over the moon, but I was tired, it was a lot of hard work.

[01:19:35]

Two years later, another big thing, and this is the move from Bracknell to Exeter.

Yeah.

No interruption in your service?

Yeah.

Were you involved in that process?

Yes, there were ninety separate projects and I was given one of the pear-shaped ones, which was we'd identified thirty customers that had their own telecoms links to us. So this is the days when everything's not on the internet, you often had leased lines, because that's where you guaranteed performance. Because even in those days the internet would go down on a Tuesday, nobody would fix it, because somewhere in there, there's an academic looking after it, you know. And you then try and sign something with Jisc or with the academic people for your internet connection and say, we'd like to send commercial data over it. No, you can't do that. Well, can you give us a guarantee that you'll repair it? No, we won't give you a guarantee, it's an academic network. So lots of people had leased lines. And we had a policy of a leased line has an A end and a B end, right? You own the line, you pay for it, you pay BT or Cable & Wireless for it, or Sprint or whoever owns, who run the cable. And if you're paying for it, you own the A end and the customer has the B end. But about thirty customers who had the same policy, so British Airways, for example, owned the A end, they owned the link to us. And I had the job of going round to all of them and explaining, we are going to move down to Exeter, so the initial response from, oh, you're a government department, you're going to move by next December, we don't believe you, we're not going to do anything. So the BBC was another one, they were a bit sceptical. And eventually I was told I wasn't allowed to go without an account manager, I couldn't go as a techie, right? The account manager was a bit of a pain because they always said, oh, this is a bit complicated. No, it isn't. It's a bit of string goes from A to B, right, we own A, they own... and we can move B if we wish. But if they own the A end, they have to move the B end, right? And you've got until December whenever the date was to move it. And a lot of them didn't believe it and it wasn't until I got a letter on file that basically said, we are moving, this is the deadline, we would like you to move the B end of your cable down to Exeter, we suggest you have a one-month overlap so you could transition, and if you haven't done it by then we'll terminate the contract and we'll forego the money from you, we don't care. It's much more important to move. Signed by the chief executive, right? Once I got that letter on file to go to each of the thirty people, I felt much more

relaxed. And it was interesting, like the BBC, for example, I remember going down with Alison, who was the account manager for the BBC, she used to be a forecaster on TV, and just saying, can you explain to me how the BBC works. And they said, oh, they've contracted it out, the telecoms. And said, who is it? And I said, is it one man and a dog? And they said, no, no, there are two men - and one dog - and so it was literally, it was a two-person company that were running the telecoms for the BBC to the Met Office, right. We knew the BBC got the forecast correctly because we'd set it up so that there was a return signal. So when we sent the forecast to them, in whatever format it was, it may be a satellite image or radar image or may be a data file, we'd send it back to ourselves from the system there, so we knew they'd got it. And we did that with other government departments, and there's some interesting stories to tell there as well, about nuclear accidents, but we'll do that another time. So what we ended up doing was I think we persuaded the BBC they should buy another router or another pair of routers, because not only did they own the cable, they owned the router in our computer hall, right. So I think we lent them one and we took the spare, there was a spare, we insisted there would be a spare so that if things went down on the BBC we could just switch out their old router and put in a new one without waiting for an engineer to come from America or wherever, or BBC. And we just ferried it there on the back seat of Alison's car and got it changed. And then I remember talking to the BBC guy and I just said, who owns, where are the passwords for the router? He said, oh, they're in my head. I said, don't mind me being rude, but what if you walk out today and you're knocked over by a bus. He said, hm. I said, how about putting the passwords in a safe somewhere, you have a safe? Yes. How about putting passwords in the safe and giving the combination of the safe to somebody else. [laughs] So this idea of risk analysis was not very, not very well addressed in the IT industry, to be honest.

[01:24:51]

Anyway, so for example, we lost the BA contract. It terminated. The BA said, oh, we're not moving on time, we're not doing this, we're not paying for- the leased line down to Exeter is much more expensive than, yeah, from West Drayton to Exeter would be five times, ten times more expensive than one to Bracknell. And so for a couple of years we had no contract with British Airways. They just got the standard

safety forecast that went out to all international aviation, they didn't have any special service. They had a special service for, you know, for tail winds for optimising their fuel consumption and things like that, they just dropped it. And then eventually they kind of paid the money and paid for a line all the way down to Exeter. But of course that's all gone, there's hardly any leased lines now, I don't think.

Yeah. In your coming up for fifty years, you're in your fiftieth year, in your coming up for fifty years, what are the biggest mistakes you've made, Chris?

Ah.

Final question.

Yeah. I... I think some of the mistakes have been, while I think about what the mistakes were, is I think some of them were fuelled by not trusting my own confidence, occasionally listening to other people and then saying, no, they're wrong, I'm going to do this. So some things that really worked and people don't even know that they worked, but I can move the goalposts or move the playing field, was where I kind of just listened to my voice and said, look, I've done my research, I've done the work, I've, you know, nobody else could do any better, or very little better, that's how it is and that's obviously the clear decision, whether it's strategic or tactical, right, I was really happy with that. But occasionally I've listened to people and I've kind of been persuaded, no, it doesn't seem quite right. Now, which mistakes have I made? Certainly in my third generation of data assimilation I tried to make things too complicated. I really thought I could write an all-singing, all-dancing, thinking of all possible cases and program it. So the kind of things you would do is you're processing a grid of data, it's a multi-dimensional grid and you've designed it so that actually the computer is, even if it's a supercomputer and there's as much memory you can stick on a computer, you cannot get it all in memory at once. So you stage it from storage into memory. And of course you've taken grids from the previous forecast, the data assimilation, and you're outputting another grid for another forecast and you may be taking, you know, so there's this kind of step-wise integration of these different grids. And I thought I could generalise it so it was kind of, you just put in the configuration parameters for the grid and the whole thing would work. But in

fact it's much simpler to just hard code everything. And other colleagues had discovered that. So when we were doing things like, the very first model was on an octagonal grid. As I said, it went down, it's on a polar stereographic map projection and it went down to about fifteen degrees north, you know, so it just caught the edge of the Tropics. But square, but actually the bits in the corners went down below the equator and it was a bit meaningless, so it was made octagonal shape. And one of my colleagues, Pete, Pete Trevelyan, who joined the Office the same week as me, he discovered that actually, if you just scanned, if you just did your do loops across the whole square and didn't put in those IF tests to take out the triangular corners, it ran much faster. Okay, it produced a bit of garbage in the corner, but then you just threw it away. You know, so doing things simpler and hard coded is sometimes, gets what you want. And trying to kind of think of the possibilities- I seem to remember somebody once said that if you're trying to make a piece of software fool-proof, you have to remember fools are very, very smart.

[laughs] That's a very good point to end on. Thank you so much for a very inspirational contribution to the Archives. Chris Little, thank you very much.

Nice to speak to you.

[01:29:18 end of recording]