NATIONAL Life stories

IN PARTNERSHIP WITH

BRITISH LIBRARY

NATIONAL LIFE STORIES

AN ORAL HISTORY OF BRITISH SCIENCE

Sir Alan Cottrell

Interviewed by Thomas Lean

C1379/46

This interview and transcript is accessible via http://sounds.bl.uk.

Oral History
The British Library
96 Euston Road
London
NW1 2DB
United Kingdom

+44 (0)20 7412 7404
oralhistory@bl.uk

Every effort is made to ensure the accuracy of this transcript, however no transcript is an exact translation of the spoken word, and this document is intended to be a guide to the original recording, not replace it. Should you find any errors please inform the Oral History curators.

The British Library Interview Summary Sheet		National Life Stories Title Page	
Ref no: C1379/46			
Collection title:	An Oral History of British Science		
Interviewee's surname:	Cottrell	Title:	Professor Sir
Interviewee's forename:	Alan	Sex:	Male
Occupation:	Metallurgist, Government Scientific Advisor.	Date and place of birth:	Birmingham 17 July 1919
Mother's occupation:		Father's occupation:	Property manager
Dates of recording, Compact flash cards used, tracks (from – to): 15 March 2011.			
Location of interview:	Interviewee's home, Cambridge.		
Name of interviewer:	Thomas Lean		
Type of recorder:	Marantz PMD661 on secure digital		
Recording format :	WAV 24 bit 48 kHz		
Total no. of tracks	1	Mono or stereo	Stereo
Total Duration: (HH:MM:SS)	1:34:12		
Additional material:	Short written biography.		
Copyright/Clearance:			
Interviewer's comments:	Short interview intended to supplement written biography.		

[Track 1]

My parents gave me three priceless gifts, a good brain, a happy temperament and good health for long life, so that was good, yes. At school I was a fairly dreamy child, I never worked very hard and I just drifted through school really. But somehow I was always able to do well in examinations and I won various school prizes on the strength of that, yeah. I had lots of hobbies of course, er, Meccano was the central hobby, but then there were Hornby trains, hmmm, model yachts, model aeroplanes, flying model aeroplanes, elastic aeroplanes and all that, the usual things. Also I had chemistry and electrical sets and they really got me interested in science so that's what steered my way in the direction of science, yes. And then in 1936 I took my school finals and I was offered a scholarship to Birmingham University by the Birmingham City Council who they must have been a rather enlightened council in those days [laughs], I don't know whether they still do it but it – that took me to the university. I wanted to read physics but my schoolmaster strongly advised me against, which I now realise was bad advice, so I – I went to see various science and engineering heads of departments at the university and the head of metallurgy, Professor Hanson, had such a – a persuasive voice that I went in his department, even though I knew practically nothing about metallurgy in those those. But I went in there and, er, again I never worked terribly hard but I developed lots of interests at those times. I – tennis and swimming, hill walking, fly fishing for trout was another interest, and then in the university itself classical music, I've always been very fond of classical music. And also contract bridge, I used to spend a lot of my university time, misspent it rather, playing bridge [laughs]. And then I graduated in July 1939, I was just about to start research in the department when the war began.

[02.48]

I was wondering, could you describe what each of your parents was like to me?

Pardon?

Could you describe what each of your parents was like to me please?

Well, it's hard to say, my father wasn't as tall as I am and he was a bit stockier I think. And my mother was a bit short and, er … my father was interested in engineering subjects, although he hadn't had such a great education of that. My mother was musical, I guess that's where I get it from, she was very fond of singing and she used to take music lessons, yes.

When you said they gave you a good brain, did they encourage your education?

Yes, they were very keen on that, that's right. They put – I wasn't pushing at all myself, they were doing all the pushing for me, yes, they were very keen on education for me, yes.

What was your father's occupation?

He was a manager in my – his father owned various pieces of property in Birmingham and my father managed them for him, yes, so was a manager of property really, yes yes.

[03.58]

When you said that your hobbies included Meccano and Hornby trains –

Yeah.

I was wondering what about Meccano actually attracted you to it?

Pardon?

What did you like about Meccano?

Well it was the ability to construct all sorts of interesting things and that, yes, you could simply make things by sort of doing all the nuts and bolts together, yeah, so it's just [laughs] – it was a very interesting enjoyable hobby that was, yeah.

[04.28]

Hmm. Why were you dreamy at school?

Pardon?

Why – why do you think you were dreamy at school?

I don't know, it's just the way I was made [laughs], yes. Yes, but I remember one story, I – at school, one afternoon we had the mathematics class, the master took us through one of, er, Euclid's theorems in geometry and I listened to it, then the following morning we had another maths lesson and he – he preceded to work through that same theorem again. Well since I'd already heard it the previous afternoon I was bored with it so I went into one of my daydreams which he spotted and at the end of his thing he – with – giving a broad wink to the rest of the class he said, 'Now Cottrell will stand up and repeat that theorem,' I stood up and rattled it off at top speed [both laugh], he was absolutely flabbergasted, yes [laughs]. Yes.

Did you enjoy school?

Yes yes, I did, yes. Particularly the later stages, the sixth form particularly I enjoyed, yes.

When you said that your headmaster had suggested you not do physics but that was a mistake?

The physics master had – yeah.

Physics master, yeah, why did he say it was a mistake not to do physics?

I think because – well yes he said, 'You'll become a schoolmaster,' that's what he said and he obviously disliked the – being a schoolmaster himself [laughs]. That was a bad mistake because physicists were needed in the war of course, yes.

What actually attracted you to metallurgy, was it just Professor Hanson or were there other things -

It was just Professor Hanson, yes [laughs]. I didn't know what it was in those days.

How was he so persuasive? How did he persuade you?

Well just he was a good persuader; he had an eloquent voice, yes [laughs].

What were the parts of your university education that you actually enjoyed the most?

Oh, well all of it really I think, yes yes.

Hmmm, had you had much thoughts about what you wanted to do after university?

Not really, no, I was – as I say in those days I sort of drifted along rather, let things happen to me rather [laughs] yes. And of course I – well I started on a research subjects as soon as I graduated but I had to give that up immediately when the war began of course, yeah.

[07.10]

What did you do when the war started?

Well I applied to join the forces, in fact I think I was aimed for the Royal Armoury Brigade but I was then sent back to the department to do war research instead, and so I spent the war years doing war research, yes. Several bits of war research but the main bit was on the electric arc welding of armoured plate for tanks. Tank armour has

to be very hard and strong, well you can – ordinary steel, carbon steel, as you know from antiquity, you can harden it by heating it red hot and then plunging it rapidly into cold water, the very rapid cooling causes the crystal structure of the metal to change into a – a very hard form, you obviously can't do that with great thick chunks of tank armour, it would cool too slowly and be too awkward to do. So tank armour is made of an alloy steel in which you have small amounts of nickel and chrome which belong to other things, they slow down the crystal change into that hard state so much that it hardens even by ordinary cooling in air so that solves that problem. And of course the welder – the arc welding cycle takes the metal hot and cools it down so the welding cycle also does the same thing. But the welding and the tank armour at the beginning of the war was – had a very serious problem; the welds were all cracking and it – obviously it was very weak and fragile, I was given the job of finding out why and what to do about it [laughs]. And, er – well I – I'd started to inspect it and I found that the cracks were not occurring in the welds but in the metal at the side of the welds, and that gave me a clue that it was something to do with the hardening process. Well I did a lot of experiments then which gradually confirmed that and proved it, that the metal in the weld – at the side of the welds was hardening into a very hardened brittle state and then with the stresses on the metal it was breaking very easily. Well once that was known there was a solution to the problem which was to line the faces of the weld with a thin layer of a non-hardened type of steel, not the alloy steel but another sort which would not harden, so that insulated the – the hardening steel from the high heat of the welding, sufficiently to stop the process happening, so that solved the problem, yes [laughs]. Of course there was a lot more work to do at various aspects of that but that was the basic thing, yeah.

Where did you actually do that work?

In the university – in the department, yes. I had – had to do the welding myself, I – I became an expert welder [laughs] just 'cause I had to – it was – research in those days was very much a DIY activity, yes [laughs], you did it all yourself [laughs].

Could you describe maybe once of the experiments you actually did in the process of that research on the armour plate?

Yes, well one of the … it was known that the – the change of crystal structure into the very hard state occurred at a temperature of about 200 degrees centigrade roughly, it was a late stage in the cooling down and – well I measured it in the steel, it's not too difficult to measure that and the next thing I did, I – I – I determined the temperature at which the cracks formed, I made a special gadget which – which a mirror would flick when the – the metal cracked and the – the flick told me when it cracked and with a – had a thermocouple in the side of the weld and that told me the temperature and it cracked just below 200 degrees centigrade, so that was a pretty clear clue as to what was happening, yes. That was one of the experiments I did, yeah.

Hmmm, how did you feel about being a scientist in wartime, rather than going into the forces as you'd originally wanted?

Well I felt very privileged in a way, I felt that the country had held me back from having to go in and fight and so on and I felt that I – I owed something to the country in return [laughs] and – and that feeling of wanting my research to have something useful to the country about it, that's lasted for the rest of my life really, it stems from that initial stage, yes.

[12.14]

Who were your closest colleagues at this time?

Well I … I had a supervisor who was in charge of the research, but I have to say between ourselves he was absolutely hopeless, although I'd never done any research before I knew infinitely more about research than he did and after – I think Hanson also spotted this, after a year he – he moved off and I was in charge of the project, and then I had about three or four younger research students working under me for the project, yes.

[12.53]

And what other jobs did you do in wartime?

Pardon?

What other jobs did you do in wartime?

Oh I did a bit of work on Admiralty bronzes for the Navy, and also I did a bit of work on cylinder liners for the Merlo engine – Merlin engine, aero engine which they had to be very hard indeed, the cylinder liners, of course they – they fitted into an aluminium engine 'cause aluminium is light so you had to have that for an aircraft but you had a – a thin cylinder of very hard steel which – where the piston ran and that – I was involved in the hardening of that, getting it very very hard by introducing nitrogen into the metal, nitrating it was called, yes, and the nitrogen made it very hard. Yes.

Did you actually work at all with serving military officers with the actual end results of these things?

Not really, it was all done in a rather indirect way, yes.

Hmm.

Yes.

[13.55]

Could you give me some idea of what your hobbies and interests were outside of work in this period during the war?

Yes, well … tennis and swimming were two main hobbies, hill walking, fly fishing for trout, I – I did that for – quite a lot, in the Welsh border country which is not too far from Birmingham. Not in the war, but after the war, you couldn't get there much in the war, but after the war we did that, yes. And at the university I – every lunch

hour I spent a couple of hours playing bridge when I should have been working [laughs]. And classical music, I also had learned to play the piano in those days as well, yes.

[14.45]

Could you give me some idea of what it was actually like working at the Bir – University of Birmingham at this time? Maybe could you just describe what you would do on a – on a day?

Well I … I'd just get on with the research really, yes yes. But later in the – towards the end of the war I was also lecturing, I became a lecturer in 1944 so I was giving a bit of lecturing as well. Yes, and – and at the end of – towards the end of the war Hanson invited me to create a new lecture course on the physics of metals, he was very forward looking Hanson was, he was looking to the post-war period and getting ready for it. And this suited me very well because by then I'd become very interested in the atomic science of metals, that is understanding what metals are and what they do in terms of what the atoms and the electrons inside them were doing. That is to explain it all in terms of atoms and electrons and of course this course absolutely suited me for that so I – I gave the course for many years afterwards and wrote one or two textbooks about it, yes.

How did you become interested in the atomic structure of metals?

Well I don't know, it just – it just grew [laughs]. Well there was a – there was a short textbook which I read which greatly interested me but not a lot was known about it in those days, I could see there were more problems than solutions [laughs]. Yeah.

How different was the atomic understanding of metal that you were teaching compared to the existing approaches used elsewhere?

Very different, yes yes, the – the – the existing approach was very empirical in a way, there was – there was some science about it, phase diagrams for studying alloys and

that but that – that was about all and there was metallography which I enjoyed, that's looking at metals under the microscope, yes, I – I enjoyed that and, er, that's how it got – but Hanson himself was interested in the atomic side of things, although an older generation he hadn't got so much knowledge about it as I'd got. Yes, yes.

What about your work actually interested you most?

Pardon?

What about your work interested you?

Well I'd – it – after the war Hanson got some research money and – and let me choose a new research subject of my own so I – I chose to work on the plastic properties of metals, that is … plastic deformation, that sort of thing, deformation is the -

So bending metal then?

Bending and stretching, that's right. And there – there was a great mystery of them 'cause there was a theory that metals deform plastically by the movement of things inside the crystals which were called dislocations, which was a sort of systematic irregularity of the crystal structure, and that could move about and in so doing it displaced one part of the crystal relative to another and that was – that was how the thing became plastic. But no-one had ever seen or proved any of this sort of dislocation, so with Hanson's research money I set out to do that and, er, together with a young research student from Cambridge, who he was doing experimental work and I was doing the theory work, and incidentally he was Hanson's son-in-law [laughs] so that's how the connection came through Hanson, yes, he'd made the connection.

Who was it?

Robert Cahn, he's dead now, he died three days – three years ago, yeah. But he did – he did experimental work on plasticity of metals and found some peculiar effects at the time I was doing the theory of dislocations, and I discovered some – what you might call counterintuitive properties of dislocations, things that you would not expect on a naïve piece of science. I realise that Robert Cahn's peculiar effects were precisely due to these counterintuitive properties, so that connection established the reality of the dislocations. So that was a good thing. And the other main thing I did, ordinary common steel has a very peculiar feature when it starts to deform plastically and I realise that was due to some special properties of dislocations, and er, I was elected into the Royal Society on the strength of that [laughs], yes.

How did you feel to be elected to the Royal Society?

Well it was a great honour and something I never expected of course, yes yes [laughs]. Yes. That was 1955, yes.

What benefits does being a member of the Royal Society get you in the 1950s?

Well it, er, carried prestige of course, yes. And when I was at Harwell the – it carried a bit of weight there, yes [both laugh].

Oh.

[20.33]

What sort of laboratory facilities did you have at Birmingham?

Primitive, we hadn't – the thing we lacked most was money so we had to manage [laughs], so it was very much a DIY outfit, yes, yes.

Were there many laboratory technicians and research assistants?

Yeah, yes, there were, yeah yeah.

What sort of work did they do?

Well they'd – so the workshop was the most useful, making gadgets, particularly the welding research during the war had – had a lot of things made in the workshop for that. Yes.

Hmmm.

[21.17]

You mentioned earlier on that you also met your wife when you were at Birmingham?

Yes, in 1944, we got married, that's right [laughs],yes.

How did you meet?

Pardon?

How did you meet?

We met because she was working locally, there was a – just outside the university the Iron & Steel Institute had had a small corrosion laboratory and she was working in the corrosion laboratory and that's how we met, 'cause it was a local meeting, yes.

Hmmm, what was her name?

Jean, Jean yes.

When did you decide to marry?

1944 we got married, yes.

Hmmm. Did you have any children?

Yes, I had – after a few years had a son Geoffrey, who you saw his photograph over there. And then very much later we had an – an adopted daughter, Johanna, yes.

Hmmm. What do your children do?

Geoffrey is a scientist, he works at Culham in the plasma physics laboratory. And Johanna works – she lives, well she's married of course, got a family, but she – she's a medical and she works as a nurse at Oxford College, yes.

So both your children went into scientific fields as well almost then?

Well all – except Johanna's was medical rather than scientific, yes. Yeah.

[22.58]

In 1955 I was invited to go to the Atomic Energy Establishment at Harwell which I accepted, but I thought that they would have national problems there which fell into my field, and that was right. The two main things I did there, they were designing the Magnox reactors in those days, Magnox reactors for electricity production and they – uranium fuel rods were arranged to stand vertically, one above another but they relied on the solidity of the metal to stop it bottling. But I – I predicted, and then I proved experimentally that while it was being eradiated, the uranium, although it would remain solid would behave actually as if it were a stiff liquid, so in – like pitch, you know, pitch is a stiff liquid and – and it would – 'cause of that it would gradually buckle and hit the sides of the channels and stick there and that would ruin the reactor, and I calculated the reactor would last two weeks before that happened, only two weeks, yeah. Well they had to redesign it then, design the reactors so that to support the uranium so that it – it was the supports that carried the weight and not the metal and that solved that problem, that was one problem, yeah.

How did they actually take to you explaining why the reactor wouldn't work in that way?

Pardon?

How did people take to you actually explaining why the reactor wouldn't work [laughs]?

Well it was the northern group, they were designing the reactors, they – they took what I was saying very seriously and they did their own experiments which confirmed mine and so that's how it went on from there, but had they been against it we wouldn't have had any Magnox reactors [both laugh], so they get a lot of the credit as well for taking me seriously, yeah.

How did you actually – did you do any experiments along the way to help you discover this would be a problem?

Yes yes. That was – had all sorts of difficulties, because I had few facilities at Harwell, I had to eradiate uranium and then measure its distortion and I did that by making a uranium wire in the form of a spring with a little weight on the end and all sealed up in a vacuum, held it into the reactor in the end of a fishing line [laughs], my trout fishing, and then we could only look at it via mirrors because it was ferociously radioactive when it came out of course, it's raw uranium you see, and so we measured the – with a theodolite onto a mirror into the thing so it measured the increase in the spring link, that's how we did that. It was a difficult and ingenious experiment but it worked, yes [laughs].

Was your work dangerous at all?

Pardon?

Was your work dangerous at all?

Oh yes yes, I mean I – I knew what I was doing so I felt safe [laughs]. But yes …

How – how did you feel about nuclear power at this time in the 1950s?

Well it seemed to be very important that we should have it to solve fuel problems, yes.

Hmm.

I was – I was entirely interested in the electricity production from it, yes. That was the side I always worked on.

Where did you actually work, at Harwell or – ?

Harwell, yes, in Berkshire, yes. About ten miles south of Oxford, yes.

Could you describe what your laboratory was like?

Well it was a big institution of course, it's enormous – an enormous place then, lots of facilities and so on, yeah. Yeah. I mean to show you the facility – I'd tell you the second main thing I did which was a – in 1957 a nuclear reactor, not a Magnox, an early type of reactor at Windscale caught fire and that caused a national emergency, you probably heard about that somewhere along the line. And that caught fire because they were doing a gentle heating of the graphite – graphite – solid graphite reactor and they were gently heating the graphite because the radiation knocks carbon atoms out of position in the lattice crystal and every so often you have to heat it gently to get them back into position, otherwise it – the graphite would become unstable, and they were doing that and when the graphite atoms moved back into position in the crystal, they give out a little bit of energy and unfortunately they gave out too much energy so the graphite got hot and caught fire and, er, I was then asked to form and lead a group to investigate that to see whether it would occur in the Magnox reactors. And we had to work in a great hurry, had – construction – complete laboratory with all the equipment, special equipment for it in six weeks, that's [laughs] 'cause I had

all full priorities then, you know, you had the directors sort of backing and everything – the way was cleared and everyone helped then so that was good but – and I was very glad after about a year I was able to tell them that the Magnox reactors were safe against that problem, so that was that one, yeah.

What – what sort of work did you do to prove that the reactors were safe?

Well you had to take samples of graphite from Magnox – under Magnox conditions and measure the heat release from them, so the special equipment was a series of special colour images which would measure the heat releases and we – we did a huge plot of the heat releases under various conditions, that's how we did it you see, find out how much and how far the temperature would go and so on, you know.

[29.38]

How much freedom did you have in your work, working at the Atomic Energy Agency, were you always being directed to certain tasks or was there freedom for you to actually explore things a bit more?

Well I was … I mean the main problems I – were there and I – I chose – well not – that problem of course was given to me, the graphite problem. The earlier problem was chosen freely, the one of about the bottling the uranium, that – that just occurred to me out of the blue, yes. So I had a lot of freedom to think about things out of the blue. Hmm.

[30.25]

You've been an academic scientist working in a university before this, I was wondering was it different being a government scientist?

It was, very different, yes yes.

Could you tell me some of the ways it differed?

It – in some ways it was harsher and more competitive, the – I – I – perhaps Birmingham was exceptional, Birmingham was a very happy department, everybody enjoyed it and they all celebrated each others work, but Harwell there was a certain amount of jealousy going on, I felt the atmosphere was a bit tougher, yeah, hmmm.

Could you give me perhaps an example of how that was clear to you?

… Well I – the head of the department in metallurgy at Harwell, he used to bypass his senior lieutenants and go to the junior people directly and that – that upset them quite a lot, yes.

Did you enjoy working there?

So-so I think, I – I didn't enjoy it as much as I did at Birmingham, no, but I got a lot of satisfaction out of the problems I solved, yeah, 'cause they were problems of national importance then, yeah.

Who were your closest colleagues at Harwell?

Well I – I had a small team and, er, they were my closest colleagues, yes, the people in this team, the senior members of this small team. Yeah.

And who else was in the team?

Pardon?

Who else was in the team?

About half a dozen, yeah.

All scientists or engineers and technicians?

All scientists, yes, yeah.

Hmmm, were there any people you already knew there?

Some of them were, yes yes, some of them were new though, I mean I'd not known before but one of them was one of my old students at Birmingham, yes so –

Who was that?

Churchman, Trevor Churchman, yes.

Hmmm. When you said that you thought the work you were doing was of national importance, was that something that was important to you?

Yes it was, yes, I always – had stemmed from my wartime experience that I – I was always especially keen on doing things that were for the national good as it were, yes.

How did you actually come to be working at the Atomic Energy Agency in the first place?

Well I was invited there, yes.

Who by?

By Monty Finniston. He was the head of the department there, yeah.

Is he a metallurgist as well?

Yes, yes.

Oh, what was he like?

Oh, er … very vigorous I would say [laughs], yes. Yeah.

Why did you decide to leave the Atomic Energy Agency?

Well I got an invitation to come to Cambridge in – when was that 1958 I think, yes, '58 and I was invited to come and be a head of metallurgy at Cambridge so they – I was glad to go back to academic life and of course Cambridge was a prestige place, yeah. I found that my main job when I got here was to modernise the department at – it was a bit backward when I went there and I – I brought in some new people and some new equipment, I also started to teach the subject from the atomic point of view which I'd not done before, yes, and that brightened it all up and I –

So it hadn't been taught from the atomic point of view before at Cambridge?

No, no.

Even though you'd been doing it since the '40s and –

More traditional way, yeah.

Hmmm.

And I started some new research projects and things, yes. Several new research projects, modern branches of the subject.

When you said you brought in new people and new equipment, who were the – who were the people you brought in?

Lecturers mainly, yeah, about three – I was – the university granted me about three posts I brought in there, Doctor Kelly who I'll mention in a moment, who became Professor Kelly ultimately, Robin Nicholson and, er, Jim Charles. Jim Charles is – although he's in retirement there he's – I still have coffee with him in the – yes, in …

Did you know all of them already or – or any for reputation?

Not really, no. I knew them by reputation, yes yeah.

Hmmm. When you said you brought in new equipment.

Electromicroscopes, yes [laughs].

Oh.

Yes, I bought a modern electromicroscope, I – I got research money from the AEA and also the Electricity Generating Board, they provided quite a lot of research funds for me so [laughs] electromicroscope, yes [both laugh].

How did you convince them to be so generous [laughs]?

By the work I'd done for them, yes [laughs]

Oh. What difference did actually having an electromicroscope mean to the work that you were doing?

Well I didn't actually use it myself, but Robin Nicholson came in and it was an exciting time 'cause that was the time when it was discovered how to see dislocations in electromicroscope for the first time.

Sorry, what's a dislocation again?

It's the irregularity of crystal structure which can move about inside the crystal and it causes the crystal to change its shape, hmm.

So you hadn't been able to see it at all before this point?

Not – no no.

What difference does that actually make to how you can do metallurgy?

Well it – it – it finds the whole basis of the plastic mechanical properties of the metals, yes.

Hmm.

[37.10]

When you said you started some new research projects.

Oh yes.

What were they on?

One was on superconductivity, you know what that is, yes, oh certain – some metals when they're very very cold will conduct electricity perfectly, and er, that's becoming of practical importance in specialised medical equipment and so on, also in the – the – the big nuclear accelerator in CERN, you know, in – that's – has superconducting rings that –

Large Hadron Collider?

Yes, the Collider, yes. That was – that's usually superconducting metals to – to let the beams go round, yeah.

Why did you decide on superconductors at this particular time?

Because I could see there was going to be some applications of it, yes, practical applications, yes.

What sort of practical applications were you thinking of?

Well medical and that, mainly yeah.

What were the other areas of research?

Er … fibre strengthening, oh this is work I did with Professor Kelly, although he was Doctor Kelly in those days. We – we did the basic theory of fibre – strong fibres and we realised that by making a – a lot of fine fibres and gluing them all together into a solid lump you could use extremely brittle materials joined together by an extremely brittle glue and yet the whole thing was very resistant to cracking and was very strong. And we developed the – the scientific understanding of that, before it had ever appeared in practice. And of course gradually over the years that led to new materials, fibre glass and carbon fibre, those arose out of that discovery of – that you could make very strong tough crack resistant materials from very brittle stuff in that way, yes. That's what I did with Doctor Kelly, yeah.

Hmmm.

And many years later I even advised Edward Heath to make spars of his boat from carbon fibre [both laugh], yes. I don't know whether he did but that was my advice to him, yes [laughs].

Did you have any specific ideas for what things like – was carbon fibre in your mind at this point?

Fishing rods [laughs], tennis rackets [both laugh].

Were these things you were actually thinking of at the time?

Boats, boat holes, yeah yeah.

Oh.

[40.14]

I was wondering actually, as – as, you know, an academic scientist working in Cambridge, how connected is your work to the applications of it in the real world?

Well that was important, I always felt we had to do the practical side of a subject and that's why I brought in Jim Charles from industry, he had a good industrial understanding of metallurgy and I developed a practical side of the subject to – we got steel ingots and analysed them microscopically to find out the substructure of the steel ingots for the – that was a practical side of the work, yeah.

Hmm, what did you see as the most important things you had to do to modernise the department?

Teaching it from the atomic point of view, yes [both laugh]. Yeah.

[41.13]

Bearing in mind that I'm not a metallurgist myself, I was wondering if you could just explain to me, what difference to doing metallurgy does it make to actually metals from the atomic point of view?

Well it means you know what you're doing, whereas before it was trial and error, this time you can actually design metals and alloys, I mean the – the alloys used in jet engines have all been designed on the scientific basis you see.

Hmm.

They work at temperatures that would be impossible by an empirical approach, in – they actually – you put in very tiny clumps of – of a foreign material in the metal which block the movement of the dislocations, and so they're unable to make the metal plastic, even at the very high temperatures, that's why they – the jet engine alloys will work at sort of very high temperatures, 'cause you're blocking the dislocations, doing it scientifically [laughs].

And you can actually see this on an electromicroscope?

Yes, yes yes. Nicholson was taking photographs of that, yes.

Oh.

[42.30]

Who else was actually in – who did you work most closely with, you mentioned Doctor Kelly.

Doctor Kelly, er, Nicholson, Jim Charles, yes, can't remember anyone else now [laughs]. Oh Bruce Bilby, I did a lot – he went off – he worked – went off to Sheffield but we still worked by correspondence, we're both [inaud] and we're doing the strength and fracture of steel, we did that together, I did a lot of work on the strength and fracture of steel with him, yes.

Hmmm.

Bilby, Bruce Bilby, yeah.

When you were say you were doing work on these things, were you actually in a laboratory doing experiments, or reading results later, or what sort of activities were you doing in this work?

Well yes, particularly in my earlier days it was laboratory work but gradually I – over the years I gradually became more and more theoretical, worked with a pencil and paper instead of a laboratory, yes [laughs], but I had research students working in the laboratory, yeah.

Hmm. How do the two things actually combine, you know, the theoretical work and the laboratory work?

Oh they combine very well, yes, the theory suggested experiments which you wouldn't otherwise have thought of, and the experiments gave you facts for the theory to bite onto, yes [laughs], it worked very well, yeah.

Hmm.

[44.05]

What did you enjoy most about being at Cambridge as head of metallurgy?

Well I – it was a happy department again, I just enjoyed running it and they all got on well and did a lot of interesting things, yeah. Yes.

What for you personally were the most interesting parts of it?

Oh I suppose the teaching side, yes. I enjoyed teaching, always did, yes [laughs].

Oh. Not many academics usually say that, why did you enjoy teaching so much?

Well I – I found teaching was a way of clearing my mind on a subject, that's why – the main thing I think, if you're going to give a lecture on a thing you really have to understand it and get your mind clear [laughs], yes, so I enjoyed doing that, yes.

Oh. So is it teaching lectures or teaching practical classes as well?

Lectures, yes, not much – I didn't do much practical class work, yeah.

Does a head of department have any other duties apart from –

Pardon?

Does – what are the other duties of a head of department?

Managing the budget [laughs], yeah.

I always wonder about that sort of thing, does – does it get in the way of research time or …?

Oh yes yes yes, I had to spend a lot of time on administration, yes, hiring and firing, you know [laughs]. All that I had to do, yes.

Do you have any other duties in the university?

Pardon?

Do you have any other duties in the university?

Oh yes, I was on the university committees, yes yes. I was on the council of the senate as well, yes, that was the – the top administrative body at the university, yeah.

[45.51]

I was wondering as an academic scientist, did you keep those links up with the government scientists you'd known before at all?

Yes, I was on various government committees, yes. There – there were various scientific committees in London and that I used to go. And also I was – I was on the – the board of the AEA, Atomic Energy Authority for a while. [Sneezing] Excuse me. So I had to go to London quite a lot, a couple of days a week at some times, yeah.

What sort of committees, just give me perhaps one or two examples?

Well there was scientific advisory committees.

How did you feel about doing that sort of government science work at the same time as the –

Well that led me into the next stage, I began to think more about government policy and I – I developed a strong feeling at that time that, er, British industry needed brightening up with more science and that eventually led me into Whitehall, so Solly Zuckerman and Lord Mountbatten got their eyes on me through those London committees and they persuaded me to go into Whitehall. I went in because I thought I could do some good for brightening up industry with science but that may have been a bit of a mistake, but anyway I went in to Whitehall and I – and I started off with Dennis Healey's defence review, I went into the Ministry of Defence onto Solly Zuckerman, I was very much involved in the defence review. And I didn't – for this I – I led various inter service teams, this was when I met the military, the top brass [laughs], the very top military brass they were, and I – I was the – the head of various teams that investigated what were called scenarios, which were imagined war situations and they were all to do with East of Suez, 'cause the defence review was asking the question about the expenditure of East of Suez activities and we gradually realised that to be successful East of Suez you need to provide air cover over an enormous area and although we investigated one or two other ways of doing that, we finally came to the conclusion, the only successful way or certain way of doing that was have two or three aircraft carriers out there all the time, and the sheer cost of that put the end to that enquiry and so they – the government cancelled the East of Suez policy as a result of their – just too expensive, hmm, that was the main thing I did at first in Whitehall.

When you said that Zuckerman –

And then after a while Solly Zuckerman moved over to the cabinet office as the government chief scientific advisor, I went with him as his deputy and there we were doing all sorts of science for government. Any government issue which had a scientific aspect we would get involved in it and so there was all sorts of problems we were working on there, yes.

Could you give me one or two examples?

Brain drain, we did some work on the brain drain, er, space research, Concorde, advanced passenger train, Torrey Canyon disaster, do you remember the Torrey Canyon, that was a – a big oil tanker in the channel which ran onto rocks and spilt all the oil out and it – it swamped the beaches and – Devon and Cornwall with – with oil and – and that – that was a big – major disaster. In the end the RAF were allowed to bomb it which they took on with great joy [laughs], peacetime bombing, yes. And we did all that and … well then Solly Zuckerman retired and I became the chief scientific advisor, this was 1962 I think, was it – let me see … no 19 – 19 – 1966 that was, yes. I became chief scientific advisor but there was a major complication 'cause Edward Heath, who was the Prime Minister at the time, brought in Victor Rothschild, Lord Rothschild with a team called the Central Policy Review Staff and they really had a rather similar ticket to me so it was a major complication for me. And I – I had a difficult time with that.

What sort of –

But anyway, the way it worked out is that Victor overreached himself and got into serious trouble, 'cause there were things known as the government research councils, Medical Research Council, Agricultural Research Council, which stood pretty independent of government and Victor Rothschild wanted them brought into government departments so that their work would be more directly connected with the national interest, and research councils got furious at that and Rothschild didn't know what to do about it and I suggested to him – I said, 'Leave the councils with their independence, but the main departments that use their type of work, give each such department a chief scientific advisor so that he could direct that department's work towards the research councils and he'd be a paying customer to the research council for that work,' and Rothschild accepted that idea, was delighted with it actually, and that became the basis of what he called his Customer Contractor Principle, and so that – that squared things up with Rothschild and myself quite a lot [laughs], yes.

Hmm, why did you think that was a good solution?

Pardon?

Why did you suggest that as a solution, what did you see the benefits as?

Well I get – they preserve the council's independence which was what they wanted more than anything. And it gave the departments a more of a vote into the councils 'cause they would pay for the research and so they would get – get the council to do more of their own research, instead of independent research.

Hmm. Did you see the independence of the councils as important?

Yes yes.

Why?

'Cause they – in that way they could attract really bright scientists. Scientists, really bright ones, would only work if they could be independent [laughs]. The prima donnas [both laugh].

Hmmm.

[53.42]

Well anyway that took me onto, er – when – when did that take me onto –

Up to 1974 I think.

1974, then Jesus College invited me to become the head of the college, I was very glad to get back into academic life and also to get back full-time to my family again because I'd been commuting into London.

Would you mind if I asked a few more questions on your role in Whitehall?

Pardon?

Would you mind if I asked a few more questions on what you did in Whitehall?

Yeah, sure yeah.

I was just wondering when you said that Zuckerman and White – and Mountbatten had had their eye on you, I –

Sorry?

When you said that Zuckerman and Mountbatten had had their eye on you over those meetings [laughs].

Yeah.

I was just wondering, how did they actually approach you to do the job?

Well Zuckerman approached me first, and then Mountbatten approached me at a feast in Christ College Cambridge where he was an honorary fellow. He marched up the hall in the middle of the feast and more or less in the Kitchener way, he said, 'Whitehall needs you,' [both laugh].

What did you think about that?

Well I was very sorry to leave the university and the – the department but I – I say because I felt that government industry needed something doing about it, that's why I went to Whitehall, yeah.

I was interested when you said that you thought that industry needed something done about it, I was just wondering what – what you thought was the problem was?

Well I thought it – industry was running too much by non-scientific people and accountants and it was falling behind Germany in a lot of things, and of course Japan as well it fell behind, yes – yes never really recovered its position there, lost a lot of good industries that way.

[55.37]

What did you think about the idea of the white hot revolution that's happening around the same –

Well I was keen on that of course when Wilson mentioned it but, er, I later discovered it was only politician's utterance, it had no backing to it at all [laughs].

Why do you say that?

Well when I got into Whitehall I discovered what Wilson was really interested in, he was really interested in holding his party together [both laugh].

Oh.

[56.11]

I was wondering – I was wondering what Solly Zuckerman was actually like to work with as well?

Scheming I think, I have to say bluntly, he was a – he was brilliant at getting to know influential people and that's the way he worked, yeah [laughs].

How did you get on with him personally?

So so I think, yes. Yeah. One thing I admired him, he was – he was very much against nuclear weapons and he land – he led a long campaign in Whitehall against nuclear weapons and I admired him for that, yeah.

On what grounds?

The danger of them, yes. There was a great move to have what they called battle – hmmm, battlefield nuclear weapons which were small nuclear weapons and Zuckerman realised that small would quickly grow into large and so there's a terrible danger and he – he fought very hard against battlefield nuclear weapons and one – have never had any battlefield nuclear weapons as a result of that and I was – that was a major contribution I think in Whitehall.

Hmmm.

I was not involved on the nuclear weapons side but I – I saw what he was doing there, yeah.

Hmmm.

[57.42]

You mentioned a variety of the different jobs you did with Solly Zuckerman, I was wondering if you could just a little more about each of them, you mentioned the brain drain.

Well my memory's a bit vague on them really, yes. I – well I'll tell you one job we did, yes, which fitted in with – with my idea of brightening up British industry was that we would aim to try to reduce the amount of money spent on government defence research and turn that money instead into research for civil industry, we tried very hard to do that but we failed because of the treasury. The treasury was very keen to reduce the – the defence research which they did, they were not the slightest bit interested in putting money into civil industry, so they just refused to do that. So that – that failed and we made quite an effort in that, yes. Yeah. Oh I tell you another thing I did about – I've talked about Rothschild in the – the government chief scientific advisors, going round – when Solly had left I think, going round Whitehall

at that time was a – a bit of a campaign to have a minister for science, I opposed that 'cause I – I was pretty sure that such a minister would be a failure 'cause he would be in a very weak position relative to the ministers of the big spending departments. I mean a big spending department is doing his own science, you couldn't have an outsider interfering with that and particularly with the small – only a small budgetary zone, so he'd always be in a very weak position and so I advised against the minister of science and that advice was taken. And instead I said the big spending departments should have their own scientific advisors so that they can become informed customers for scientific work. That was the second reason for that idea, yeah.

Hmm. I was actually wondering as well –

Pardon?

I was wondering, did you just become chief scientific advisor because you had been a deputy beforehand, was it just succession that way?

Yes, I think so, yes.

Or –

I think so, yeah.

Or did anyone actually offer you the job along the way or [laughs] was it just taken as red?

Pardon?

Did anybody actually – did you have an interview for the job or was it just –

No, it just happened, yes, I just got a letter for it [laughs], yes.

What did you see the duties of chief scientific advisor as?

To inform the government on scientific aspects of its various policies.

Were there any parts of that work you particularly enjoyed or disliked?

Well to take an example, the government was very keen on what I call glamorous projects, like space launches and Concorde, which I realise these were not economic things and while Germany was putting its money into economic things, like machine tools and motor vehicles and things, we were putting our money into uneconomic things like Concorde and space research and so I – I advised the government very much on that, yeah. I lost out on space research because – on, er, Concorde, I advised against it, 'cause I thought it was much too expensive for the small number of people it would carry. But Wedgwood Benn who was minister of technology then, I think he was in favour of it for some political reasons and because he was a minister and had more pull he won and I didn't [laughs], yes.

Oh. When you talked about the space aspects of this, was this in connection with any particular British programmes or –

Well yes, we had one or two space launcher programmes, Blue Streak and Black Knight they were called yes.

And Black Arrow as well as –

Black Arrow, that's right, yes, Black Arrow was one of them, yes. I said in space what we should concentrate on is – is building communication satellites, which we did in the end so I – I think I won on the space side, we haven't built any space launches, but we have built communication satellites which go up and are used, yes.

Why did you think that Britain should be out of the space launcher business?

Too expensive. And competing with America which could afford those things [laughs].

Hmm. Why did you think that Britain should be in communication satellites?

Economic, get a return on that, yes [both laugh].

Oh. Did you encounter much opposition to these ideas?

Pardon?

Did you encounter much opposition to those two ideas?

Yes, the industry was – the aerospace industry was very keen to do the space launches 'cause it meant loads of government money coming their way [laughs].

[01.03.11]

What were the other big duties – the other big parts of your job, the big issues of the day as it were when you were the chief scientific advisor?

Well there were lots of things, I can't remember them in detail, I – I used to have to go abroad quite a lot to represent the country and … and NATO science committee, I was on the NATO science committee then, used to have to go to Brussels regularly for that, yes. Did – help to determine the science aspects of NATOs policy, yeah.

Was it a busy job?

Yes, it was a busy job, yes. Yes.

Could you give me some idea of what a working week would be like, you mentioned that you used to come back home at weekends, I wasn't quite –

Yes, I used to go on the morning – Monday morning train, get there mid morning and then work continuously till Friday afternoon and then come home again, yeah. Yeah.

What does work actually consist of, is it meetings mainly or other –

Meetings and writing memoranda things, I mean I wrote quite a number of government memoranda and things which were published, so –

Hmmm.

[01.04.28]

You mentioned Victor Rothschild and some difficulties with you both being in a similar sort of job – job role.

Yes yeah.

I was wondering if you could just elaborate on that a little bit, what sort of difficulties?

Well he had – he was – he had the strong backing of the prime minister and so he got lots of commissions from the prime minster to do investigations and things and a lot of – some of it impinged – and since he had a scientific background himself he naturally tended to swing over to the scientific side of things.

Oh.

Yes.

Is he someone you worked with personally or –

Pardon?

Is he someone you worked with personally?

Well I had a small staff of course with people, yes. And I worked with – quite a lot with Lord Jellicoe who was the Lord Privy Seal and he had a scientific ticket. I also worked a little bit earlier on with Margaret Thatcher 'cause she was minister for education and science and she was far too busy with education, which meant problems with schools basically, she had to – that took her full-time so she couldn't spent many time on science but when she had to give a speech about what she was doing, she used to ask me to write some scientific stuff to go into a speech which I did, yes. So if you go and read her speeches and you come to the scientific passage, I wrote that [both laugh].

[01.06.07]

Working as a – you know, as a scientist in Whitehall, I was wondering in what you saw of science as being important for Britain, what was its role in British life?

Oh, well I think the – the general public never really properly understood it, it's – I think things got better, you get some quite good scientific problems on the television now but whether the general public watch them or not I don't know, but they're quite good programmes, yes.

Hmm. What –

I think even the educated general public tend to be frightened of science, I found that in Whitehall 'cause they were mainly classics people in Whitehall of course and, er, they had no idea what science was and they were hostile to it on the whole, yes, 'cause they were frightened of it I think, yeah.

And I had – I did mean to ask actually, what is it like – as a scientist, with the scientific training working in an environment surrounded by people who are classicists and –

It was very strange, yes, but I – I admired them, they worked very hard and very responsibly on the whole, yes.

So you think there was a need for more scientists there?

Yes, I thought so, yes.

Hmm.

[01.07.28]

I was wondering, you mentioned there were discussions over the rearrangement of the research councils, if you could just tell me a little bit more about the sorts of discussions that went on?

Oh … well the research councils ran a great campaign against the Rothschild – the first Rothschild proposal, and even the second one, the – the one that came from my idea of the chief scientific advisor, I had a gigantic correspondence on that. In a few weeks I filled an entire four storey filing cabinet with letters from the scientific communication out in the wilds [laughs], yes, about it yes [laughs].

Oh. Was it a hot topic at the time then?

Yes it was, yes yes. *The Times* newspaper had columns on it as well [laughs], yes.

Could you give me an idea of some of the different viewpoints that there were in the debate?

Well it all boiled down to one thing, we want to keep our independence. And of course I was in favour of that because it meant that our – I mean they had some really brilliant scientists, particularly the medical research council there, really top flight medical research people they had, yes, I think it was important to preserve their goodwill.

Why the need for the reorganisation at all?

Pardon?

Why the need for the reorganisation?

Well it was only really to solve the Rothschild problem 'cause he wanted – he wanted the government departments, like the Ministry of Health and so on and the agricultural department, to have a bit more influence in the research – what the research councils were doing. And he had this rather unfortunate proposal to do it and my – my proposal was a better one which would make those ministers customers, paying customers, and they would get the research done that way, yes.

Hmmm.

[01.09.44]

How much – you mentioned you worked with a variety of different politicians and ministers over the years, I was just wondering how some of the people you've mentioned, Margaret Thatcher, Tony Benn for instance, actually took to scientific advice from yourself, or advice on scientific matters?

Well Dennis Healey was the best I think, he was a classicist but he – he had a brilliant mind and he could understand the scientific aspects of defence work, yeah, I think I admired him the best, I think he was the brightest brain amongst the people I met. Harold Wilson, I – was really too much of a politician, as I say he was only interested in preserving his party's unity. Edward Heath, I've – although he had a very stiff personality and difficult personality, I found him a very genuine man, and – and he would always listen intensely to what you were saying and if he thought it was good it would sink into him, become part of his outlook, yes. And I admired him for that, yes. Yeah, as I say poor Margaret Thatcher at that time, she was – she was just busy dealing with school problems to listen to science, yes. Yeah.

What about Tony Benn?

He was a brilliant orator and I think that led him astray at times into unsafe directions, yes, like supporting Concorde for example [laughs], yes.

[01.11.21]

You mentioned, erm, that you thought science needed to sort of have some economic benefit.

Yes.

I was just wondering if you could just explain that viewpoint a little more to me, it's –

Well it was to raise Britain's competitiveness by introducing new scientific things onto the market, yes. I mean Germany did that with the machine tools, it took over the machine tool market 'cause it put its scientists into designing better machine tools, whereas at the time we were designing space rockets instead.

Hmm. Where were any aspects of this you were particularly keen on, any British projects?

Not particularly, no, I just – so long as it was bringing good economic benefit to the country that was the main thing and it didn't really matter what area it was in, yes.

Hmmm.

I would say that – the exception to what I would say is the British pharmaceutical industry which I – has always been very scientific industry and has done very well and is – is one of the best British industries as a result of that.

Hmmm.

So I would not criticise the pharmaceutical industry at all.

Did the pharmaceutical industry come with your bailiwick?

Well it would do, yes, in a way, yes.

Hmmm.

But it was running pretty well already so I didn't have to – didn't need any bandages as it were [laughs], yes [both laugh].

And how did you feel about being a scientific advisor compared to a practising scientist?

Well I – I've always – basically I'm a – an academic scientist, I mean I did the – the government science because of my interest in trying to brighten up the British industry and so on but what I really liked doing was academic science, yes. That's why I was glad to go back to Cambridge, yes [both laugh], even though I went as a master, not as a scientist.

Why did you decide to leave, was it because of that reason?

'Cause I got the invitation to become master of the college, that was very attractive and, er, I'd got tired of struggling in Whitehall by then, yes [both laugh].

What is it actually like working in Whitehall?

It was interesting I would say, but a bit frustrating, yes.

What were the frustrations?

Well there was various frustrations, I'd say there was – you're working amongst all the classicists who didn't really understand you and ministers were really only to – mainly – only interested in politics and not the science, yeah.

Working in that sort of environment how much weight do you think your – your voices, CSA actually carried?

Well I – I – some things I achieved, I think I – we didn't have space launches, yes and [laughs] –

Are there any bits of your work during that period you're particularly proud of or unhappy with?

Oh I don't know, well probably the – the work I did on – on the East of Suez policy, that was too expensive, yes [both laugh].

[01.14.50]

How did you feel about returning to Cambridge?

Oh I was very glad to come back, yes, and – and of course Jean also – she enjoyed coming to the college very much, she enjoyed the college enormously, particularly getting to know all the undergraduates, she was giving sherry parties and things like that which were a great pleasure, yeah.

What sort of duties does the master of a college actually have?

Well I can only tell you what I had, the – the main duty I had when I came to the college was leading a – a general revision of the college statutes which took about a year's hard work, working through it all very thoroughly. And then getting ready to admit the women into the college, that was also a lot of preparatory work to do that. Yes. That was a great success actually. The first woman we elected was a fellow, that was Doctor Lisa Jardine, you know Lisa Jardine, yes, I admitted her into the – her fellowship, yes, and then the undergraduates came a couple of years later. They played a great part in the college, the women, yes, it was a most successful thing, yeah.

Was the admission of women a difficult process at all?

Well there were some die hard fellows that were against it [laughs].

Even –

Particularly older ones, yes.

Why were they against it?

Tradition I think, yes [laughs].

What did you feel about it yourself?

Oh I was very keen on it, I thought it'd be a good thing and it turned out to be a good thing, yes.

Hmm.

[01.16.30]

When you were actually master of the college did you have any research interests as well or did they have to –

Yes, I – well not much while I was master but when I retired from the mastership I – I went back to doing – back to the department, I used to go in and do some research there, back to plasticity problems again, yeah. Mainly to do with the – the creep of metals at high temperatures, you know they – they slowly stretch, very slowly, like lead runs off – off sloping roofs, drips away very slowly and I studied that a lot when I went back to the department, yeah.

What attracted you to that problem in particular?

Er … well I think it goes back to Professor Andrade who was a professor of physics in – before the war, he discovered that the – the metal creeps as – stretches as the cube root of the time, takes the one third, and that was very intriguing, and no-one could explain it and I worked a lot on that and finally came up with an explanation for it, which pleased Andrade very much indeed [laughs], yes.

Hmm. [laughs]

[01.17.54]

I've been interested actually, someone who's been in material science, you know, since the 1940s, still doing research on it in the 1970s and beyond, what do you think the biggest changes in the field have actually been?

Oh I think going over to electronic materials, yes, that's the – that's a gigantic side of the subject now and I – I've never been on that, although I – I did a little bit of work on the electrical properties of metals, electronics properties, but the true semi-conductor side and all that, I've not been in on that at all and that's a gigantic field now, yes.

Hmm. Did you foresee it coming when you were a younger scientist?

Oh I think so, yes. It was pretty obvious, yes, right from the – the – early 1947 I think when they first made the transistor, it was – it was obviously going to grow and grow and grow, that's – yes [laughs]. Take over all the old valves, yes, and [both laugh] – 'cause it was all valve radio in my – when I was young, yeah.

And had the equipment you were using to actually do metallurgy research changed at all?

Pardon?

Had the equipment you were using to do metallurgy research changed over your career?

Well electromicroscopes came in of course and they had been very important. And then all the electronics stuff which come in, yeah, so – I mean in my early days you – you did it all with valve circuits and things, yes [laughs].

What sort of electronic things?

Well computers and all the – you know, the controllers and everything of that kind, yes.

Hmmm.

[01.19.46]

You were master of the college for how many years?

Twelve years, yes.

That's – what do you think were the changes you saw over that period?

Well the main change was the admission of women, that was a gigantic change, yes. And of course we had Prince Edward as an undergraduate, that was quite a change, yes, and I think he was very happy in the college 'cause he – I think he'd found the school – the school rather strict in discipline and he – to come into the relaxed college atmosphere was a great treat for him, yes [laughs]. Yes.

What did you like about being master of a college?

Pardon?

What did you like about being master of the college?

Well I liked the undergraduates best, they were so enthusiastic and charming and Jean loved the undergraduates, yes [laughs], and having the sherry parties with them, yeah. And the undergraduate societies, music societies and the boat club and that, yeah, all of that was very pleasant and enjoyable, yeah.

When did you become vice chancellor?

1977 I think, for two years, yes.

Is that at the same time as being master of –

Yes yes, yeah. I had to give up about half the masters duties of course to be vice chancellor, just temporarily, it was only a couple of years, yeah.

What sort of duties does a vice chancellor have?

Solving petty problems I would say, that's what I did mainly [laughs], yes. I hadn't realised that all the enormous numbers of disputes and complaints and things, they all ended up on the vice chancellor's desk and – successful vice chancellor never appeared in public, only the failures got to the public [laughs] – yes, so I was very busy solving a lot of those things. And of course there was a great deal of official entertaining of visitors and that, including the chancellor. Prince Philip used to come and stay with us in the large – in the – he was a regular visitor in those days so we saw a lot of him, yes.

Do you – were you still on any other committees in – elsewhere and –

Pardon?

Were you –

Oh yes, well I was a – I was head of all the main committees of the university of course. And also some London committees representing the university here, the vice chancellor's meeting, yeah.

Were you on any other committees elsewhere, government advisory committees for instance?

Yes, I was, erm, still doing some government advisory work, yes.

On what sort of subjects?

I did … aerospace materials I think, yes, I was – had a lot to do with that. Jet engine materials and that, I had a lot of work with Rolls Royce on that, yes. I used to go to Rolls Royce quite a lot and that – Julia King was at Rolls Royce for a while, you must have noted that when you interviewed her, she was there, she was at Rolls Royce when I used to go, yeah.

Hmmm.

[01.23.05]

Are there any students you've worked with along the way you've risen up into higher places now?

Oh yes yes. Although not only risen up to higher places, they've retired I think, yes [both laugh].

Are there any students of your own that you're particularly happy with?

Pardon?

Are there any of your students who you're quite proud of the progress they've made over the years?

Oh, well yes John Knott who was my research student and he was – he later became the supervisor of Julia King, he was one of my best research students and he – he became the head of metallurgy at Birmingham, I think he's retired now. And who else is – oh I can't remember them all now [laughs], my memory is fading, yes [both laugh]. Yes, Trevor Churchman was – he became quite senior in the electrical research industry, yes. And – no they've gone now the names I'm afraid, yes.

Hmmm.

[01.24.21]

I was wondering, when do you think you've been happiest in your life and career?

Academic work, yes. I've enjoyed all my three sessions in universities, yes [both laugh].

It's an interesting career, you know, sort of mixing government scientist and being –

Yes, I always say it's – it's been a Rondo my career, university, non-university, university, non-university, university, A B A B A B A, yes [laughs], A Rondo structure in music, yes [laughs].

Hmm. Is that something that you – do you think has had any benefits to you?

Pardon?

Is that sort of two track career something you – has been beneficial to you?

The non-university parts broaden my outlook very much of course, yes, and led me into the wider world. I – I mean I got to know all the government ministers and so on and that and industry people and that, yes, which I probably wouldn't have done if I'd stayed in university all the time, yeah.

I wonder, are those sorts of connections to industry and government actually useful to you as a university scientist later on?

Well, I used to get research contracts from industry which paid for equipment like electron microscopes, yes [laughs].

[01.25.47]

How did you feel when you started approaching retirement?

Well I didn't mind 'cause I … I mean I was – I was glad to give up the college administration, I'd got a bit bored of it after twelve years and going into retirement meant I could go back to science again, I went back to the department doing research and I rather liked that, yes, I was glad to do that, yes.

Hmm, what sort of research interests did you develop in your retirement?

Well I said earlier, mainly on the creep of metals, yes. Now I did a little bit of work also on the electronic structure of alloys, yes, not much on that but a bit, yeah, but mainly on the creep of metals, yes.

We talked a little bit about your interests outside of work when you were younger as a student, I was just wondering what other interests have you developed over the years from that point?

I suppose music was a major interest, yes, I've always been very fond of music, playing the piano and so on and – of course now I'm deaf I can't really enjoy it very much, yes. I've replaced it with reading [laughs], yes. Yes, and – well I – when I was younger I used to enjoy tennis and swimming quite a lot and – and for most of my life and with Jean hill walking was – always been a great thing, we – we used to have holidays in the Alps and then in the Lake District, regularly, yes and – until we got a bit too stiff to do it [laughs], yes.

I mean I –

I always enjoyed trout fishing as well, fly fishing for trout, yes.

What's the attraction, I've never fished in my life so I wouldn't know?

Oh it's hard – well it's a very difficult art, it's an art fly fishing, you – very skilled, you have to be good at it otherwise you never catch anything, yes [laughs]. And it's – it was the delicacy and skill of it I think which attracted me, yeah.

Hmm.

[01.28.01]

I meant to ask as well, when you were growing up did you have any particular religious or political outlook on the world?

I've – I've gradually grown less religious I think in life, yes, particularly when Jean died, I found that I wasn't really very religious, yes.

Hmmm, had you been brought up religiously?

Mildly, I – not – I don't think my parents were very religious but they encouraged me to go to Sunday school, things like that which I – it – it never really soaked into me [laughs].

Do you think that's partly due to your scientific interests as well?

Well I – probably yes, yes, I – I was never really convinced by the religious stories, they were fairy – they were fairy tales, very largely [laughs], yes.

[01.29.01]

Did your parents have any particular political outlook at all?

No, been slightly right of centre I would say, yes [laughs]. Yes, I've always been slightly more towards Conservative than anything else, yes.

Hmmm.

[01.29.20]

I was wondering what you regard as being the most interesting things that you've done in your career, those one or two particular projects or jobs that you're most interested by?

Oh, well I suppose the things I did at Harwell were the most important. The – in the design of reactors and so on, they were the most important and that, and the other thing I think is establishing the reality of dislocations, that was important as well, scientifically important that was. I think those are the main things, yes. And of course the war work on the welding of the tanks, yes.

What's most interested you about the work you've actually been doing as a scientist?

What?

What's actually most interested you about those – those – those jobs that you've enjoyed doing?

The theory I think, working things out in my head, yes. Yes, although in the early days I did quite a lot of experimental work but I – I think I'm interested mainly in the – getting the theory right and of course that goes back to the atomic theory side of it all, yeah, explaining everything in terms of what the atoms are doing, that's what I've always enjoyed most, yeah.

Why does the theoretical side appeal to you more?

Well it's just me I think, yes [both laugh].

Hmm, yeah.

Yeah.

That's interesting, I – I'm – you know, I'm not a scientist myself so it's all science as far as I'm concerned, I was just – I was just wondering if there was anything about the theoretical side of it that appealed to you more than actually doing the practical work?

Well the theoretical side is that side the leads to the understanding, the experimental side leads to the facts, and often you can't move forward without some facts and – like I'm – a problem I've been studying for the last year, I'm stuck because I haven't got enough facts to get me going on it and it's been frustrating me for the last year, yes [laughs]. But – so the experimental side provides the facts, but the theory provides the understanding and the understanding is much more satisfying than the facts, yes.

What problem are you working on now, if you don't mind me asking – if it's –

Well it's a plasticity problem, it's – if you – you can turn metals into single crystals which is very good for studying plasticity in its simplest form, and when you stretch a metal single, say a copper or an aluminium single crystal, it gradually gets harder, but I think we understand why it gets harder but the curve by which it gets harder starts off very flat and then goes more steep and goes all funny later on. And that – well I think qualitatively we can understand that, my aim for the last year has been to provide a – a quantitative guide to that, to calculate that curve and I find I haven't got enough facts to be able to do it properly so [laughs] that's the frustration, yes. Yeah.

I guess that more or less brings us right up to the present day doesn't it?

Absolutely, yes, I – yes.

And I have one final question which is how have you felt about taking part in this interview today?

Oh quite happy with it, yes yes [laughs]. Yes.

Good.

Oh just one final thing, since I've had to give up music I – I've taken a lot to reading in later times and I find I enjoy ancient history a lot, Romans and Greeks and early medieval stuff, I enjoy that a lot. And the other thing I read is modern physics 'cause I – I find quantum mechanics an absolutely fascinating part of science, wonderful – it – quantum mechanics tells you that the world is absolutely weird, it really is weird. You can have a given thing in two different places at once, things like that and it's – it's absolutely true, and you get all that out of quantum mechanics, that's how – I'm never tired of reading that subject these days [laughs], yes.

That does bring me another question into mind though, you mentioned that your –

Pardon?

You mentioned that your school physics teacher had suggested you not be a physicist.

Yeah.

I notice a lot of the work you've done along the way has been, you know, at the theoretical end of things.

Yes, it really has been physics, yes. Yes. I was really a physicist [laughs], even though I didn't train that way, yes [both laugh].

Well –

Yeah.

Is there anything else you'd like to add before –

No no, that's fine, yes, have you got it all, yeah?

Nothing – so thank you very much.

Jolly good, yes, well that's good, yeah.

[End of Track 1]

[End of interview]

