Hans Bachor: 00:00:00 Professor Hans Bachor interviewing Professor Ian Sloan for the Conversations with Australian Scientists Program on 16th May 2022, for the Australian Academy of Science. Good morning, Ian.

Ian Sloan: 00:00:18 Good morning, Hans.

Hans Bachor: 00:00:21 Thank you for coming for this interview. Well, it's not, it's a conversation. Let's start at the beginning. Who, and what inspired you to study science and mathematics at school?

Ian Sloan: 00:00:34 I suppose that's an easy one in that my father was a mathematics teacher and he taught me. In many ways he was very interested himself in science. I have an interesting background I suppose, I think. My grandfather, my father's father was not a highly educated man, he was a postmaster, a local postmaster and he was a famous VFL - Victorian Football League - footballer. He was a captain of Fitzroy when they won the first Premiership back in the end of the 19th century.

What I think is that people of course didn't have the opportunities in those days, but because he got famous through football, he actually had a very successful career as a rowing coach for Scotch College in Melbourne. And that is important. I believe that's important in my story because my father then went to Scotch. I don't know how exactly, but he surely got there, and it was a very good place to go, of course.

He was a polymath. At Scotch College, he finished up as Captain of the school, as Dux of the school. As Captain of boats, as Captain of football, everything, he just did everything. He was a big influence on my life. He was headmaster of my school in Ballarat for all my school days and I greatly admired him.

What I think is interesting, and may be insightful, is that he himself was a fine scholar and a fine sportsman. He used to play annually, the teachers would play the boys and he was the star of the football team. 'Get out of the way boys...coming through'. His heroes were the scientists. He had a great admiration for the great theoretical physicists of the 1930s and so on. He in fact was at Cambridge himself doing the Math Tripos just before the Second World War and his heroes were people like Mark Oliphant FAA, whom he knew there.

So, I guess it was rather easy. I was always interested in maths and science, as well as other things. That means that we had a lot of interests in common. I was not such a great sportsman. My brother was a very good sportsman, and he was jealous of my relationship, it turned out in later years, because my father seemed to appreciate the scholarship more.

Hans Bachor:	00:03:18	Ian, you came from Melbourne, at the time we didn't have AFL, we had VFL.
Ian Sloan:	00:03:24	Yes.
Hans Bachor:	00:03:25	Victorian Football League.
Ian Sloan:	00:03:27	Yes.
Hans Bachor:	00:03:27	You ended up, via England, in Sydney. How did you survive with different football codes?
Ian Sloan:	00:03:34	Well, easily, I suppose. My son played rugby. My wife and I both became very interested in rugby and we're more or less totally uninterested in Australian Rules Football anymore. We are now rugby aficionados, but we're still proud of that old tradition. It's remarkable, because I suppose I'm getting on, but [when] my grandfather was Captain of Fitzroy, this is still in the 19th century. 1898, I think it was. The question is interesting, I think, because to me, I was always surrounded in a certain sense by a real appreciation of scientists and so on, but also by sporting people. I'm not a good sportsman, but I have always found my friends all tend to be pretty good sports people as well as scholars, I would say.
Hans Bachor:	00:04:28	So at school, the teachers, did you stand out in your sciences or did the teachers encourage you?
Ian Sloan:	00:04:35	I was good at everything, if I may say, immodestly. I wasn't so especially one-sided, I also enjoyed history, for instance. The person who most inspired me, the best teacher I had, was the history teacher, and he really made modern history seem extremely interesting.
Hans Bachor:	00:04:56	So when you came to university you started with physics, I believe?

Ian Sloan: 00:05:00 Yes. I started with physics. It seemed a natural thing to do, I suppose. Physics and mathematics, I was always interested in, I suppose, more or less equally.

Hans Bachor: 00:05:13 And for some, physics at university, is a bit different to physics at school. Was it what you expected, were there disappointments, did you discover other interests?

Ian Sloan: 00:05:26 Yes. I must say, I was an undergraduate at the University of Melbourne in physics and it seems very disloyal of me to say to my former alma mater that I thought the physics teaching was very disappointing, actually. In the final year they had this, I thought, terrible system, still think terrible system, whereby we had over the three terms, each one had eight separate blocks.

I can't remember the details, but for instance, one sort of sequence was atomic physics, followed by nuclear physics, followed by quantum theory or something. The trouble is by the time you got to atomic physics; you'd forgotten the quantum theory. It was only eight lectures. You were examined on it immediately after it, never to come back to it again. I know empirically, since I after all did a PhD in Physics, I might as well never have studied quantum mechanics. I had to begin completely from the beginning. I remembered nothing from my undergraduate days. So, I must say, I thought that was disappointing.

Hans Bachor: 00:06:29 So then the progression was to do a PhD?

Ian Sloan: 00:06:32 No. I first did an Honours Math Degree at Melbourne University, which was a bit of happy circumstance in a way, because when I finished my undergraduate degree [and] I didn't know what I was going to do. Right at the end, Russell Love who was a Professor of Pure Mathematics there, I happened to meet him at a social event, and he asked what I was going to do. And I said, "I don't know what I'm going to do". I know this sounds rather pathetic, but that's how it was. And he said, "you should do Honours Math, which is a two-year additional course". I said, I can't do that, because I dropped out of second year Applied Math. So, this is part of the colourful history.

My second year I was sowing my wild oats, you might say, and you could do two subjects instead of three at Melbourne University Science in those days. I dropped applied mathematics after three weeks because I thought it was rather boring, which is a little ironical since I like to tell my students that, since after all, I'm now a Professor of Applied Mathematics.

So anyhow, he said, "you can do second and third year together." And so, I did, and that was a marvellous piece of flexibility, because that really...I did learn something from the mathematics. What I didn't learn is that you could do research in mathematics. What I learned was very good analysis and so on, very good. I always... I have a good feeling for analysis, now a good instinct for it. And I think I've got that in my undergraduate years.

Hans Bachor: 00:08:04 And then going to England, that was the automatic choice at the time?

Ian Sloan: 00:08:09 No, it was not. I wanted to get married at the time to my present wife, Jan. So, I looked to see what jobs I could get with some research flavour. If I may explain, I applied for three different jobs at the time with the research flavour, one was Aeronautical Research Labs. One was at BHP and the other was at CSR, Colonial Sugar Refining Company, as they were at the time.

The latter, Colonial Sugar Refining Company, offered to send me to England to do a PhD at the University of London, in theoretical atomic physics. I thought what could be better? I didn't know what I wanted to do, but I thought that's an interesting topic. So that's why I went to England.

Hans Bachor: 00:08:58 That seems far-sighted of the company to send a young student for doing a PhD?

Ian Sloan: 00:09:04 Yes. I might say I was on the payroll. They didn't give me a scholarship, they put me on the payroll. Well, it was a very far-sighted company in those days, and unfortunately it didn't last. At the time I was employed they had a research laboratory of 150 people in it, in East Roseville in Sydney. By the time I came back, it'd already fallen into decay. The project I was supposed to work on had disappeared and it wasn't too long afterwards that more or less everything disappeared, the whole research laboratory disappeared.

So that is a tragic story, I suppose, of public policy about encouraging industrial research. For a period, they encouraged it with, I think, generous tax breaks. Then a change of government, change of policy, they changed their mind, and the company then just abandoned it all.

Hans Bachor: 00:09:59 So now you were then in Britain, a different lifestyle, a different city?

Ian Sloan: 00:10:05 It was the swinging 60s. I have said elsewhere that it seemed to have passed us by, we didn't notice at the time, but the public life was thrilling. There was Christine Keeler and all that sort of thing going on, scandals everywhere. We took in a lot of theatre, a lot of concerts, opera. We went out every week maybe. We went out more than a 100 times I suppose, to take in the delights of London.

So, it was a great experience and gave us lots to remember. Took three marvellous holidays on the continent, I guess. So, of course it was a wonderful time. I always thought I like this combination of science and culture, you could say, or science and travel, where you can mix them. Live in a place and get to absorb it.

So, this was great. It obviously could never go on. We obviously couldn't even afford to live where we lived if we had, as we had before we finished, a baby. It wasn't equipped for that. So it was not an ongoing existence, but anyhow, I had a job back in Sydney, so I was a bit rushed with the PhD. I finished it in two and a half years, because they wanted me back again. It turned out to be a mistake, since they didn't have anything for me to do.

Hans Bachor: 00:11:29 But you had a plan to come back?

Ian Sloan: 00:11:31 I had a plan to come back, for sure.

Hans Bachor: 00:11:33 Now let me ask you a question more from the science side. So, this was a new age coming in, you mentioned the cultural side, which was very lively, but also this was a time when computing came in, right? So, the introduction of the mainframe and the ability to use big computers?

Ian Sloan: 00:11:52 Indeed.

Hans Bachor:	00:11:52	Where you involved in any of that? Did you use them?
Ian Sloan:	00:11:57	Yes, indeed. So, it was indeed the case that the computer revolution was coming, and I am eternally grateful for it. It certainly made it much more interesting doing a PhD, as it was in theoretical physics. So, I was doing problems of scattering electrons from helium atoms, for instance, things like that. In the previous days I know how it went. A PhD student would sit down with a calculating machine for six months and solve a differential equation or whatever, but laboriously, laboriously, laboriously. So, it's really a critical thing, I think, that because computers came in we could, in fact, when proper computers came in, we could tackle more interesting problems. So as a general theme, what I think I've realized over the years, is that people have the idea sometimes perhaps, that because we have computers, we don't need mathematics. That's exactly the opposite, it's because you have computers where physicists and chemists and mathematicians can tackle much more interesting, ambitious problems, which need much more ambitious and interesting mathematics. I didn't really answer your question. The Atlas computer at Manchester was one of the first large scale computers. We could use that, we'd write a program, it went on to paper tape, and you sent off the paper tape overnight and it would come back probably with an error. So, one learned to be very painstakingly careful, but it was good. I was very grateful that I was at such a time when so much was improved, the quality of what you were doing on the one hand, and on the other hand, the quality of the problems you could tackle.
Hans Bachor:	00:13:51	Now you did physics at the time, looking back, do you think that the physics, you and the people around you, the department had a good long-term impact?
Ian Sloan:	00:14:03	Yes, I suppose. That's a difficult question. For the problems I was working in, they were say, problems involving helium, I said scattering from helium. So that's three particles, right? So, when we and other people moved onto more particles and the problems become so much harder. That in one respect, problems became just too hard in the end, too hard to do properly.

Physicists, especially chemists, have always been very good at making wonderfully effective approximations, things that really work. Chemists, especially, I think you'd agree are fantastic at doing big molecules and all that sort of thing. Introducing approximations that allow you to effectively work with them. The things we were doing were pretty hard. But still, in all the people...

Well, I, of course, was working in atomic physics and I very quickly left that field. So, I haven't been following it much. When I came back to Australia, I started working on theoretical nuclear collision problems, which are the same quantum mechanics, but somewhat different proportions, no light particle anymore, like an electron, but all heavy particles. I did a lot of work on that.

And yes, of course, it's all a contribution but I wouldn't say that anything that I have done has really lasted so well from that period. Do I think that? I know I get citations; I get requests for... I get citations from different things. I'm always interested to see how many go back so far in the past, to 50 years ago, they still come in sometimes. So, it's pleasing, at least gratifying to see that there's somebody who reads these things.

Hans Bachor: [00:15:59] Let's move on to the transition back to Australia. So, you had the opportunity to come to Sydney and I understand then that led very quickly to university life and to lecturing.

Ian Sloan: [00:16:12] Yes.

Hans Bachor: [00:16:13] So what was the lifestyle then, in Sydney at the time?

Ian Sloan: [00:16:20] Yes, so I can particularly talk about the Department of Applied Mathematics. It was indeed an exciting time in many ways. It was exciting both scientifically I think, and in a lifestyle sense.

So scientifically... Well, John M. Blatt, John Markus Blatt, was the Professor of Applied Mathematics, he'd come, not so long ago, but in the five years or so earlier, from Sydney University. He was an international star, really. Certainly, one of the most able people I've ever met. Not always the most effective, because he would get himself involved in arguments that are unproductive very often.

John Blatt was interesting in many ways. At that time his work was in theoretical nuclear physics. Blatt and Weisskopf is still a quite renowned monograph in the field. He was a colourful character in many ways. If I just talk about lifestyle for a moment, he was divorced. James Lyness was there at the time, he was [also] divorced and a real playboy, if I may say so, [my later friend] James Lyness. I regarded [the playboy scene] as very threatening, as far as I was concerned. As it happened, I lived a long way away because I lived in an area appropriate to my [former] work at CSR. But I was glad to keep my relatively new wife and bride away from these dangerous characters at the University of New South Wales.

Scientifically, well, John Blatt was always exciting. I remember he had views on quarks and quasars, this was one of his enthusiasms. After a while he changed direction into mathematical economics and so on. He had views [that] everybody's ideas about equilibrium were all wrong. Equilibrium is probably only ever quasi equilibrium, or something like that. Into mathematical economics, into computing and into other areas, and always making extraordinary contributions, but not necessarily long-lasting ones because he refused to read the literature of what anybody else had done.

So, his typical story was that he'd get into something new, publish a rather insightful bright article, the referee would say, but you haven't taken account of the fact that something like this was done by XX. Then John would look at that and say, but that's all rubbish. Then it would start a long episode of fights with the editor over some things. It's a bit unproductive as a way. I don't think he was the most effective person I knew, but certainly one of the brightest.

I was going to say, among the other people who were there at the time, in the early days, James Lyness went on to have a distinguished [career]. He was a numerical analyst actually, but everybody else there were physicists, including me. So, Barry Ninham FAA was there. Later Colin Thompson FAA, also in the Academy. Colin Pask, very bright guy. Tony Guttmann FAA , who is now in the Academy and very distinguished.

It was a very lively place. The Applied Maths [Department] of those days had an enormous influence on the development of theoretical physics, I suppose, in Australia. Applied mathematics, yes, but theoretical physics is usually not thought of as a branch of applied mathematics but for a decade or more, when I was [first] here, it was a theoretical physics department. I taught nothing but theoretical physics things. There maybe were two mathematical methods courses, but most of the time I taught quantum mechanics, and I taught solid state physics, I think. I taught electricity and magnetism, real physics stuff, which I have greatly benefited from in later years, by the way.

Yes, I remember, I taught a course on group theory and quantum mechanics once, which has stood me in wonderful stead in later years. With theoretical physics - and I don't know if you would like me to go on, but after 10 years or so - I might say at that time the University of New South Wales had no theoretical physics department. It then decided it should have a theoretical physics department. My understanding is they asked John Blatt whether he would like to move over, [and] take the whole department over. We had discussions about this, and in the end, he decided (he was not a man who needed others opinions), he decided that we'd stay in Mathematics and he would change field. Strangely enough, most of us at the same time did change, myself [included], but perhaps we come back to that later.

Hans Bachor: 00:21:34 So just for the record, when did you start lecturing at University of New South Wales?

Ian Sloan: 00:21:41 1965, I guess. As soon as I was appointed there, I had to learn new... It was the usual thing; one has to learn new things. Of course, you don't know many things, even the things you're supposed to know, you don't know very well.

We did teach of course. At UNSW, they've always had a cooperative view of the first year, which actually, I think is a very beneficial thing. Everybody, at least [in] Pure and Applied, all took part in first year [Mathematics]. That means that we all had to teach it, but you also had to compromise on teaching. Most of the time it couldn't be too abstract, it had to be reasonably useful teaching. Of course, I did that, as well as teaching specialist theoretical physics subjects.

Hans Bachor: 00:22:29 So at the time - it might be interesting to understand how mathematicians or theoretical physicists actually worked in those days. Were they working largely individually? Were you intensively working with PhD students? Or was it teams of people? How did it actually work in the research side?

Ian Sloan:	00:22:51	Yes. What an interesting question, because compared with now it was so much more individual, papers were mostly one-author papers, and mine certainly [were].

So, when I went to University of New South Wales, John Blatt suggested that maybe I should start looking at the nuclear few-body problem, the three-body problem, which he was very interested in. I don't want to give the wrong impression, we never worked together. We never worked closely, but it did get me onto thinking about scattering problems with nucleons rather than with electrons, rather than atomic physics. It was real nuclear physics.

I had to develop that on my own. I worked peacefully, nobody bothering me in those days, but I could get on and do my research. It took me quite a while before I had... Well, not so long before I was able to participate in ARC [Australian Research Council] grants. I had a postdoc. So, I worked then with postdocs, and students; Reginald Cahill at the University of Adelaide, still in theoretical physics, was one of my early students, John Aarons was an early PhD student. But it wasn't like a group. There was no group except for me and my students. And John Blatt, I should say, but we didn't pay any attention to each other's research in fact.

So, it was very different. Nowadays research in mathematics overall is much more collaborative. In my area of mathematics of computational mathematics, it seems natural to have more than one person, because you need some people with different kinds of expertise. I do believe that science is greatly enriched by working collectively, and mathematics is much improved and much more fun when you work with other people.

Hans Bachor:	00:24:50	That matches my observations, and there has been a big shift. So, it sounds like University of New South Wales was a special place. There was already Sydney University, well established, long history. So, what would've attracted academics to come to New South Wales Uni or PhD students wanting to work there?
Ian Sloan:	00:25:15	Yes. A good question. Well, John Blatt of course was unique. He came from Theoretical Physics at Sydney University. I don't

think there was any difficulty between those groups, people like Bob May (the late Lord Robert] FAA at Sydney University and Stuart Butler FAA and M R Schafroth. I didn't know Schafroth, but they were [all] stars, and Blatt was also recognized as a star.

So, I went there, I'd never heard of Sydney University... I exaggerate, but to me, Sydney University was not on my map when I came back from England, because I grew up in Melbourne. Melbourne's in a different country, as you know.

I went to University of New South Wales because they advertised for casual lecturers. So, I thought that would be interesting to do. I had an interview with John Blatt, and he said, don't do that, you don't want to be casual lecturer, come and join my department.

So, this was by accident that I got there, and I'm still there, quite a long time [on]. Why did it attract other people, students? Well, Blatt had much to do with it. I'm thinking of Tony Guttmann FAA and Colin Thompson FAA. I don't know what their story was, but I'm sure he had a big influence on this.

Hans Bachor: 00:26:44 So individuals had a big influence on the choice. I think Michael Barber FAA also studied -

Ian Sloan: 00:26:50 Excuse me, how could I forget Michael Barber, my good friend. Remaining still a good friend, Michael Barber. I should have mentioned Michael was there because he was there first as a student. He went to do a PhD with [Mark] Kac as I recall. I can't quite think where it was in the US but came back again as a member of the faculty [at UNSW]. So, what attracted him? I suppose the same things again. And people are very important.

So, at some stage, I suppose I really need to say, and you want me to say that, we went through a transition, which was my transition as well, in the mid '70's, out of theoretical physics and into computational mathematics [and other fields]. Not a deliberate policy, more I slipped into it. I seemed to have so much to do, that I never quite got back, until recently.

The department did change. By then, we had... We went through some troubled years, I think, I would say. We went through some very troubled years, because as well as John Blatt there, we had Ted (V. T.) Buchwald, [who] also came from

Sydney University. I'm sorry to say that they were at loggerheads through their 20 years of coexistence there together, in a dramatically important and ultimately almost tragic way, because they had separate departments. We had two departments of applied mathematics. One was called Applied Mathematics, that was John Blatt's and it had control theory and numerical analysis, optimization, mathematical economics, perhaps. Buchwald's Department of Theoretical, and Applied Mechanics had elasticity, fluid mechanics especially.

That's okay of itself, but they didn't get on. They didn't get on, they fought against each other. Actually, now I say, one of my distinct memories of those years, is that I finally said - as I was getting a little more senior, I suppose, and a little more obnoxious and self-opinionated - I said to John Blatt, if you're not going to do your job as head of Department, you should stand down and let somebody else do it, me, I suppose. He thought about it for some days and decided, no, he wouldn't do that. He'd pick up his game, and he did pick up his game a bit, but our relationship was never quite the same after that.

Now in the long run it perhaps was okay. Fluid mechanics became a major strength of applied mathematics at UNSW. It led to an outbreak of... No, a separation of the department [into] what is the Climate Change Research Center. So, Matthew England FAA and others left the department.

Hans Bachor: 00:29:59 Was Pitman there?

Ian Sloan: 00:30:01 [Andrew] Pitman was there briefly, but he wasn't really much involved in the School, I think. But Matthew England went through the ranks there and is a very good friend of the school. This was not a separation of anger; it was the separation of success.

The School has now built up a new strength in oceanography and so on. I must say I was very impressed when I saw the [UNSW} advertisement a couple of years ago for Lectures on Oceanography by two Fellows of The Royal Society of London. One was Herbert Huppert, who's had a part-time association with us for as long as I can remember, and the other was [UNSW's] Trevor McDougall FAA, Fellow of the Academy, and my good friend.

Well, at some point I could say, maybe I should say now, that Applied Mathematics is now very strong, I would say. Mathematics is very strong, at UNSW and very collegial. One of my proud things is that I was the first head of the joint Department of Applied Mathematics, elected by the members of both the fields. Now it is a very wide-ranging department, which I think is fine. Applied mathematics can be a very broad church.

We have had people like Michael Banner who would fly planes down low over the ocean in bad conditions to look at the waves and to measure the waves and so on, but also make models. We have people who prove theorems and so on. In the old days there was tension about this, but that's all gone, we are now very successful, I think. And [that's] something to be very proud of, I'd say.

Moving from theoretical physics to computational mathematics, numerical analysis, was the most interesting thing and most challenging thing I've ever done. I highly recommend a change of career. Now, I didn't have to change jobs, because the whole department changed at the same time, in that sense. But it was really a challenging thing to do and a rewarding thing to do. I knew nobody in the field in Australia, I knew nobody in the field anywhere in the world, in numerical analysis, computational mathematics. So, that was the hard bit.

And of course, I was already 10 years into my career. In those days, the communication was slow, but I remember writing quite a number of letters to people overseas to say, look, don't think of me as a callow graduate student, I've been around, I have a career in theoretical physics. I think I could claim a modest career, but I felt I had a career in, and I was established. I maybe had 35 papers or something in physics journals at this time.

What I found especially wonderful is that I was very quickly accepted, invited, appreciated, recognized, and I just think that's absolutely wonderful. I always found the field very open. My wife who has been with me through this whole time, she has a rather negative view about physics, in the sense that she thinks that mathematics is much more open.

I'll tell you something about it that is worth thinking about. The first thing I did when I changed fields - Ted Buchwald arranged for me to be invited as a speaker at the Australian Applied Maths Conference in the early 1970s. I had never been to such a conference. I'd never been to any conference, any time with mathematics in the title.

So, I talked about new ideas for this numerical solution of integral equations. Doesn't matter what they are, but they're often used in an application, in all sorts of applications. I thought it was absolutely wonderful, that when I spoke there everybody was very enthusiastic. The whole of the Applied Math Conference was there just to listen to me as a relatively young guy, talking about new ideas for numerical solution of something.

They [were] not all numerical analysts. Physics is much more specialized. It's a bigger field, it's much more specialized. And I thought... I'd given many talks [at] the American [Physical] Society Special Interest meetings and so on, but there the specialization is so great that very often there are only 10 people in the audience. Whereas there were 50, 100 people in the audience for this talk. For me this was transformational.

In no time - in the following year I organized the next annual conference. I was editor of the journal. I was quickly into it. I was so quickly accepted into this other field, which I think is an absolutely wonderful thing.

Hans Bachor:	00:34:57	Ian, I'm a physicist, but I'm a gadget builder. So, I love to build machines, and from my background, theoretical physics, applied mathematics is almost a continuum, because I was starting at the experimental end.
Ian Sloan:	00:35:14	Yes.
Hans Bachor:	00:35:15	You seem to make a clear distinction between the two. Is that an intellectual distinction between the way physics and mathematics is done?
Ian Sloan:	00:35:25	It's a cultural distinction. When I went into mathematics... Well, when I started doing computational mathematics I submitted a paper to Mathematics of Computation, one of the leading journals in the field, and they knocked me back. That led me to

eventually to learn some mathematics and [how] to [prove] things.

I agree that it is an absolute continuum, but people generally don't cross over, and it's amazing how distinct they are from a social, cultural point of view. Because as I perhaps mentioned before, when I started in computational mathematics, actually I knew nobody, nobody who could help me on this. [As] theoretical physicists we [had been] doing things similar in some ways or that I learned from my theoretical physics days. But [the new work] wasn't necessarily interesting to [physicists], I wasn't doing it for physics.

In applied math, we would say computational mathematics these days, but numerical analysis, I didn't know anybody in Australia. There were some very fine people in Australia, but I didn't know them. I had never been in a mathematics department in the 10 years or so I worked in theoretical physics. I'd never been in a department with mathematics in the name. I'd never been to a conference with mathematics in the name, because the crossover was almost negligible.

I was going to say Michael Osborne FAA, Fellow of the Academy, was one of the noted people. Robert Anderssen, Bob Anderssen [is] a very fine numerical analyst and also David Elliott at the University of Tasmania. They all became good friends, but I knew none at the time I crossed over, because there's just so little [crossover]. And yet, the ideas are the same. The cultural things go deeper, of course.

I love the way theoretical physicists are happy to write a paper and say at the beginning, what we really wanted to do was this, this and this - but that's too hard, so what we're doing instead is this model problem, which gives us insight. At the pure mathematics extreme, the other way, they won't say that. They'll say that let X be a fiber bundle and Y be a topologically connected doughnut, and so on, without saying why we're doing it. I hope we're getting better in the applied math in the...

So that's the good side of it, of theoretical physics. But I said, sometimes I just wish at the end of this two-page explanation of why things actually work. Insight is everything. That's good. I just wish at the end of it, they give the two-line proof that it actually does work. Because the two-line proof that the mathematicians love often gives you no insight at all. Maybe proof by contradiction. Doesn't tell you anything at all. It just tells you something doesn't work, but it doesn't tell you how it might work. So cultural differences are very great still, I think.

Hans Bachor: [00:38:20] So cultural differences. This is about people, communities, people, where do they mix? Where do they not mix? I read with great interest your recent article about "A Marriage made in Heaven", which you wrote for the Royal Society [of New South Wales], I believe. And you're giving great examples in there, where physics and mathematics and other subjects actually, maybe chemistry and others, actually meet. Is this a good progression that came out of those days?

Ian Sloan: [00:38:51] Well, it's not just mine, of course.

Hans Bachor: [00:38:53] No. But generally speaking.

Ian Sloan: [00:38:54] Well, what I think about that is, that mathematics is in fact extraordinarily powerful and used almost everywhere. Almost half the world is using mathematics, [but] you don't see that said so often. Because people talk about computer models. Most of the time a computer model is written in a computer language, but it is in fact a mathematical model.

This is the case certainly with all the climate modelling and so on. Physicists know they're using mathematics; they're using mathematics all the time. They may not refer to mathematics papers, journals, books, but they know they're using mathematics. The chemists know they're using mathematics. The engineers know they're using mathematics, but that's not what they say.

I remember former President of the Academy, Brian Anderson FAA, he's an applied mathematician, but he would never admit he was a mathematician. He used to visit us. We had good relations with the Newcastle people when he was there, but I've even chipped him about this. You managed to not say you're doing mathematics - no, in my field, it's not a good idea. He didn't say that, but I believe what he's really feeling is, that in engineering it's not good to say you are a mathematician. But he is a mathematician, a very distinguished applied mathematician.

Hans Bachor: [00:40:11] Let me cast you back to the research work you did at University New South Wales. Was there a discussion about the big topics, unresolved issues in applied mathematics? How did you actually progress? How did you choose your topics? Was there a strategy?

Ian Sloan: [00:40:32] Well the strategy... So, can I correct one thing? Do, not did. I continue to "do". I've always thought that from a point of view of me as a person, as a person doing mathematics, applied mathematics, physics, [it] is rather more a question of what can you do that will work, will make a difference?

Rather than [asking] what are the big questions for the field, I have always... [well] I've drifted from one thing to another. I sometimes think I'm something of a butterfly in the way of research. I'm looking for new things to go onto. Partly because I get bored with working in [a] field. [A field can get] worked out too. I think mathematicians often face the problem of getting worked out, of having exhausted the lode that they're working in.

I'm giving the mining analogy. You dig and dig and dig. You've run out of things, what're you going to do? I like to think of myself more as a farmer rather than a miner. I keep cultivating new areas and so on, because people who dig deeper and deeper on a narrow [front] often run out.

I'm always looking for new things to do and I think that to me is a secret of longevity. One thing I can claim I think is I've been in the field a long time and to still be active, and the secret for me, for someone like me, is to keep finding new things to do. When you get something new to do, really follow it up. Perhaps with the help of others, enlist other people to help you, learn something about a new area.

Hans Bachor: [00:42:07] It's great to see you so productive all this time, leading to new things. Where did the stimulus then come from? So, what gave you the input that this might be a new interesting question?

Ian Sloan: [00:42:21] I tell you these things are more particular, rather than general. Well, I could give one anecdote, perhaps. In my physics days, when I really worked in physics, I knew the late Ian McCarthy FAA quite well, we had quite common interests, and after I had rather left physics, I nevertheless talked to him and he said, do you know about these really interesting ideas in high dimensional integration? And I didn't know, I'd never heard of such things. But this is from physicists, also he was a Fellow, of course, Ian.

And so, he told me about this wonderful work being done by the Russians and so on, on high dimensional numerical integration, and I didn't know, I learned it then. I thought, gee, that sounds interesting. I dug into it. I put everything aside for a few weeks. I remember I put in an early ARC application on it. So, I'd had some ideas about what to do. That is an area that's still going for me, and it's an important area.

But how did it come about? Came about by - I think you could say, serendipity, happy discovery by accident - but it's also seizing the opportunity, to me, see something new, grasp it.

Hans Bachor:	00:43:41	You had your position at University of New South Wales for decades?
Ian Sloan:	00:43:47	Yes.
Hans Bachor:	00:43:47	Literally. But I believe you also travelled a lot? So that was probably another input for new ideas?
Ian Sloan:	00:43:56	Yes, absolutely. Travel of course, interaction with colleagues. I think ideas are very precious actually. I think they're also quite rare. I know some people are able to take on a lot of PhD students and give them good projects. To me, I'm not bursting with projects other people can do. I seem to have enough projects that I can do, which is not necessarily the same thing a lot of PhD students can do.

But to me, good ideas are precious. They don't come too often. But [for] a good idea, I would drop everything to... My advice about that is, drop everything. You get a good idea, drop everything, and follow it up. It may not turn to be a good idea. Often if you do follow my advice, you may find that, oh gee, that was just stupid. I had overlooked something, or I didn't understand something properly, but then you do at the end of that process, learn that you had a wrong idea about something, [which] is often as valuable as... Not as good as getting a good idea. But ideas are so precious and rare, that to me, follow them up whenever you get them, don't waste a good idea.

Hans Bachor: [00:45:04] So I understand there were quite different schools of teaching mathematics. For example, in Russia or in France or in the US. Did you encounter that in your travel? Did the culture also come through?

Ian Sloan: [00:45:20] No, not in the teaching. I haven't been involved in teaching outside of Australia.

Hans Bachor: [00:45:27] I was meaning when you travelled you met people in research, but they might have had a different cultural background?

Ian Sloan: [00:45:33] Oh, well, of course that is true. The French are very powerful mathematicians, to make a generalisation. The English tradition is a little more mixed, I think.

To me, you need to be able to profit for all these things. So, I hate the idea of ever seeing the disciplines widely separated. I hate the idea of the pure mathematicians and the applied mathematicians not being in balance, not being on song. I hate the idea of them being in separate departments, as can happen.

It's Cambridge tradition. I think it's a bad tradition. You need people to rub off each other and to stimulate each other. So, I think we have it reasonably well run here, I think.

Hans Bachor: [00:46:22] So you brought this back, and then in New South Wales, there was more of a continuum maybe than you saw somewhere else?

Ian Sloan: [00:46:30] Well, when I came back... You mean when I came back from my PhD, of course it was all theoretical physics in the department. So, there was perhaps respect, but not much interaction. I suppose it's... Well, you would like everybody to be broad in their interest, but the scientific system doesn't always help that. To get ahead, you need to... If you're a pure mathematician in algebra, you need to publish in algebra and be strong in algebra. And what you do about cultivating wider interests, may not be professionally advantageous.

But I wish everyone were broader, because so many problems, really serious problems require help from all sorts of disciplines. I might say, one of the things I'm proud of now is that we are doing some work on the cosmic microwave background and now we have a physics colleague with us doing this. This to me is a very satisfying thing, because he has expertise, he knows things that we don't know. That's the kind of thing that...I would be keen to always be broader rather than narrower.

Hans Bachor: 00:47:46 Now you gave me some names of PhD students who worked with you, and they all have very fond, very positive memories from working with you. So that is a global community or family, I guess, of people who work together. Did this happen through projects or through conferences? What is the mechanism?

Ian Sloan: 00:48:08 Oh, again, I don't think there's any universal answer. My first-

Hans Bachor: 00:48:14 No, in your case now?

Ian Sloan: 00:48:15 Yes, but even that story is not one-sided. It happened in just different ways. Maybe I'll just mention two of them. One of them, my first PhD student in computational mathematics, numerical analysis, now Professor Ivan Graham, came from England, he actually came from Scotland, is actually a Northern Irish. Anyhow, he came to do a PhD back in the '70s. Why? I think he was adventurous. He wanted to go somewhere interesting.

Then I had done no work, [had] published no papers in this field. We are still colleagues, and we have resumed being colleagues. We now have active projects again. He now has, I suppose, emeritus status at the University of Bath.

I've had several students who've come back from industry, actually. They've been very successful. I think that is really a fine thing. They've gone into the finance industry as often happens and then they think - yeah, it'd be really interesting to do something that has some ideas and some freedom. I think people in the industry particularly would like freedom to develop other ideas. And that I think is very successful, they come with more maturity.

Hans Bachor: 00:49:42 That's an interesting idea in the modern world, that you can go from university to industry, come back to academia, maybe go back to industry or wherever.

Ian Sloan: 00:49:53 I do think so, it's part of this breadth, and so on, that I am so keen on. I just love people being able to move and for the world to be such as to allow them to move. In our scientific areas, in spite of the fact that we really need breadth from people, we do everything we can to prevent people from getting that breadth, by looking only at what they publish in their own area and that sort of thing.

It's hard to publish in another area if you're not there. It takes a big investment of effort. But I really think we should try and encourage people to be broader rather than narrower. It makes me, by the way, a little bit cautious about this Olympiad, that kind of thing. Because to me, what happens with Olympiads is often the kids get off in a very young age and get very specialized very early, and sometimes don't progress intellectually, they're still...

Hans Bachor: 00:50:54 Being put on that path very early, and then following that in a linear way. May I come back to this point with computation? So, we talked about the '60s, '70s. Let's say, talk 10, 20 years ago, computers were something quite different. People learned about algorithms, models, as you said, were used everywhere. People were then also interested [in] how accurate are they? Can we trust these predictions? Weather forecasts or financial predictions? Does applied mathematics play a role in investigating how accurate things are?

Ian Sloan: 00:51:40 Yes, of course. At some level we all do it, physicists do it, everybody does it to. If you do a calculation with some integration rule, a Gaussianrule, say with a 100 points, you repeat it with 200 points and make sure you get close enough answers. You look at empirical convergence. So that's a natural strategy, which everyone does. But how much can you believe things?

The models of climate and so on, are immensely complicated and I don't think anybody would claim that you really have a good error control on them. They look for consistency, of course. Again, they look for consistency, both between different modellers and so on, and sometimes you can't prove things. There's a lot of interest in what are called particle methods now, where you prove not things about particles, but about other continuous problems.

What you do is you follow the track of a number of particles. Follow a 100 particles and see what they do. These are methods that are very difficult to get theory for, I think. So, theory now has a valuable role when you can do it. And I belong to the camp, I'm one of the people who nowadays work very much in the area of trying to prove things where you can, to give you support, so you know. It never answers everything, you never know exactly what the error will be, but you have confidence in your methods.

Can I say that one of the big challenges, I think, when you think about the future applications, is in data science and machine learning and so on, there is a real absence of theorems there. It's one of the things that tends to keep mathematicians out of it. There's a lot of intuition in machine learning and so on and deep learning, all this sort of thing. I don't criticize it. What I say is that I see it's a real challenge to have more confidence. These days, of course, people are relying a lot on machine learning. And if it's a health matter and so on, it's not good to know that these things can fail, that maybe your algorithm will not work for you and will kill you instead.

Hans Bachor: 00:53:53 So you're pointing really to opportunities, aren't you?

Ian Sloan: 00:53:56 Opportunity, yes.

Hans Bachor: 00:53:57 Opportunities for mathematics, to put a more sound base below things which we're doing?

Ian Sloan: 00:54:04 I am. That is an area presently of interest to mathematicians, interest to statisticians. We have a data science hub at UNSW now, led by the School of Mathematics in particular, the statisticians, but not exclusively dominated by [them]. I think it's very important. I think mathematics should be trying to give the lead and yet it's an area that seems hard to get a real control on.

Hans Bachor: 00:54:37 It's an interesting way, how you can put a foundation afterwards. As an architect you need a foundation, then you build, you can't change the foundation. In other fields you can actually make a better foundation while it's being built.

Ian Sloan: 00:54:53 Yes. As theorists, you can improvise. You can do it as you go along, learn as you go along. And if necessary, go back and get the foundations right and really build the building.

Hans Bachor:	00:55:06	So you mention data and big data is a big topic at the moment. You mentioned many dimensions. And I read in my preparations, you were also interested in randomness, in things like Monte Carlo. Now, Monte Carlo to me is the name of a casino in Europe. So why does a casino come into mathematics?
Ian Sloan:	00:55:28	Well, of course this is a very interesting topic. In the broad, of course, it came about in the Second World War in the Manhattan Project, where they were trying to do complicated calculations, and the scientists, they were very inventive and discovered that some things you can do very well by random methods.
Hans Bachor:	00:55:50	I guess the methods are not random, but there's some randomness?
Ian Sloan:	00:55:54	You use randomness.
Hans Bachor:	00:55:57	Yes.
Ian Sloan:	00:55:58	If you want to find the volume of some container, it actually makes perfect sense to distribute points randomly on a square, on the containing square and see what proportion of them, If you distribute them uniformly, randomly, what proportional will lie in the container. So, that gives you an estimate. That's a simple way, that's a simple Monte Carlo method for evaluating a volume or area. I suppose, going on from that, we are very interested in what are called quasi Monte Carlo methods. It's a bad name, because they're not trying to pretend to be random, but they're trying to use methods which are better than random. Mathematically better than random. That wasn't a very precise way of finding a volume, there were many other ways of doing it. The quasi Monte Carlo methods rely on throwing points around, but doing them intelligently, not randomly. So, it's a violation of randomness.
Hans Bachor:	00:56:57	You're trying to cheat the casino, right? You try to be clever to be better than the casino?
Ian Sloan:	00:57:03	Yes, yes. That is it. That is a good way of putting it, if only... So, randomness is very much... To describe random processes in

general may require a lot of random variables. That's where my interest in randomness has come from. My interest in doing high dimensional problems, which goes back to my physicist friends who introduced me to methods, some particular methods for doing high dimensional problems.

To me, it's a natural progression. Always be prepared to learn is another of my [mantra]. If you're not prepared to learn, then you are into a dead end. You will run out; you will run dry.

Hans Bachor: 00:57:49 So if I was looking for a practical example, what many dimensions are, should I think about something... I want to understand the atmosphere for predicting the weather, or is it in that direction that I need all of these variables or dimensions?

Ian Sloan: 00:58:07 I hesitate to say that we can make much contribution to the climate thing, because it's a difficult area, a very complex area. We do quite a lot of work though. In a different way there's a lot of work done in which...

Well, okay, let me just give an example now on the engineering problem of oil recovery, or oil flowing through a porous medium. Now, when you have a porous medium, just if it's in three dimensions, you have a choice, you can either try and track the path of all the porosity, the hollows, which is obviously extremely complicated. That's a mathematical problem of stupendous order.

Or you can do what engineers often do, is to treat the porosity as random, the permeability as random. But if you do that, you need a lot of random variables. If it's a fine scale thing, you may need hundreds of thousands of random variables. See, that's the kind of application, it's a high dimensional application. The randomness comes in as a tool to model complexity.

Hans Bachor: 00:59:18 Right. So oil, yes. Maybe in the future water, understanding how water flows underneath the soil. These would be areas where the engineers are looking for better techniques.

Ian Sloan: 00:59:31 They do. They often do model these things by just treating the field as random, a random field. So, when we go as mathematicians, we're trying not just to prove that things work, but rather to do things better and prove that they work. Do things better and prove that they work.

Hans Bachor: 00:59:53 Now, Ian, that's a beautiful, long story. You're still active, you're contributing, you're thinking actively about these issues. So, may I ask you, there are challenges ahead in Australia and clearly they need mathematics as well as data and statistics, is Australia well-equipped for that? Could we do something better in the way we operate, educate?

Ian Sloan: 01:00:20 Australia, I think does well, from the point of view of its academic institutions, its universities, its researchers and so on. I think it does extraordinarily well. I think we have much to be proud of, in what we are able to do.

I do worry at the present time about the way in which the Federal Government seems to treat, seems to regard universities as a hostile enemy territory. In a way I worry about the lack of support in the long run for fundamental research, because in my view, fundamental research underlies applied research. It's a total mistake to just cut out the fundamental research and what I'm thinking of, it may be applied math, but I still think it's fundamental. We're developing ways of doing things that... and we were well enough supported.

I mentioned this random field stuff, how to actually do problems like that in high dimensions for approximation problems, for finding out what's the distribution and so on. We're getting close to being able to do these things, but it is at the cutting edge. It's not just something that can be picked up out of the manual. We need the research.

We have been well-supported. I have been well-supported. That's not my complaint. I have received excellent support from the ARC over the years, and broadly speaking, the community. But I do worry about the underlying political, the strength of will in the community to put it more broadly, that will get us to do these things. And for that reason, I think it's important that we do know that mathematics does lie behind all this modelling that's done. People talk about computer models and so on, they are nearly all mathematical models.

Hans Bachor: 01:02:11 That's clearly a theme that came out of this interview, is to emphasize where the mathematics is and that it is essentially more than just a language, it's at the centre of many of the things we're doing right now.

Ian Sloan:	01:02:26	Indeed.
Hans Bachor:	01:02:27	So I hope I didn't miss out on any big questions for you, Ian.
Ian Sloan:	01:02:32	No. Well, I think it's been a very interesting conversation. I'm very happy to have been interviewed by you and I hope I shared our joint love of physics.
Hans Bachor:	01:02:45	It has been fascinating. Thank you so much, Ian.
Ian Sloan:	01:02:48	Thank you.