Robyn Williams:	00:00:01	Robin Batterham. You grew up in Brighton and you went presumably to school close by. Was that a gilded path? Did you just sail through or what?
Robin Batterham:	00:00:13	It was an interesting path. My mother had a serious injury, back injury I think, when I was really very young. So, I spent the first few years of schooling farmed out amongst relatives, one of whom lived in the country. So, I attended a country school where all of the school was in one room and that was just terrific because each class was one row, and if what you were doing was boring in your row, you just shifted into another row. And this, I found a marvellous system of education. Then I got a scholarship to Brighton Grammar, it was a music scholarship actually, and that lasted me all through my education. Then of course, went to Melbourne University.
Robyn Williams:	00:01:03	Before you rush on to that what about science teaching? You did music and you had a scholarship? Where did science begin to come in?
Robin Batterham:	00:01:12	So, it was interesting. I'm old enough, and ancient enough, and the school that I was at was conventional enough, that how well you did in Latin dictated whether you went into the science stream or the stream that was headed for other things. So I managed to get good enough grades in Latin to get into the science stream because it looked far more interesting, and apart from the fact that you had the challenge of doing the Latin. So in the science stream, the school at the time, had superb teachers. It wasn't that there was just one teacher who just lifted you out of this world. I can think of the physics teacher. He could explain almost anything in physics. That was marvellous. There was also a mathematics teacher who never used a book, like one lecture I had at a university and could just do it all in his head. And who also taught me, although I don't think I needed to be taught, that mathematics, solving applied mathematical challenges is as much about intuition as it is about method and knowledge and understanding.
Robyn Williams:	00:02:34	You imply there was a dialogue, in other words. You weren't just d'en haut en bas, as they say in France - from above, down below, when you used to take notes, it was a dialogue.
Robin Batterham:	00:02:47	These were teachers who understood that experiential learning beats didactic type teaching any day and encouraged the

students, and particularly those that wanted to be encouraged, and of course there were people who didn't want to be needless to say that's in any school. Fortunately, I had a bigger brother, I think about three years older. So that if there was any physical problems or challenges as you tend to get in boys' school, my protector was always there to be called up if necessary.

Robyn Williams: 00:03:41 Why chemical engineering when you went to the University of Melbourne?

Robin Batterham: 00:03:47 Yeah, this was interesting because I had a mother who had been a concert pianist when young and her father was a musician, a very well-known one at the time. City organist. Resident composer for the ABC actually, when they had such a thing and they looked after the Melbourne symphony orchestra. So that side was very much the music, but my father was an engineer and just so inventive. I mean, I look at the things that he invented and made his mark in the world and think, well, you know, that's really quite something. And at the time I thought, well - I look at my grandfather, the musician. I would say he led a happy life; he didn't travel much. I looked at my father who sort of worked around the world one way or another and I thought, oh, that sounds a little bit more interesting.

Robin Batterham: 00:04:44 Now, if I'm going to do engineering, can I do a combined engineering and music? And I was told, no, that's just silly. And I thought, well, that's a bit of a comeback. So looked at what sort of engineering and the one that stood out to me was chemical engineering, because you did the math's, you did the chemistry, you did the physics just as if you're doing a science degree. And it was all about being analytical, pulling things apart, if you like analysing them and then putting them back together in sometimes more imaginative ways. And that's what I've been doing on the engineering side, all of my life.

Robyn Williams: 00:05:25 Yes, Bob May - also from the Academy of Science, and also a Chief Scientist except in Britain tells the same story. He did chemical engineering and that led to zoology, mathematics, everything. In other words, it seemed to be a good portal for the future.

Robin Batterham: 00:05:43 I think it's one of those disciplines where you are grounded in what I would call the basics. Physics, chemistry and these days,

microbiology and biology as well, and with a good smattering of mathematics. That allows you to get inside anything at a reasonably fundamental level. It doesn't mean that you're expert in every area. That would be a nonsense, but it means you have the capabilities of getting into areas and actually making some judgements as to whether what you're seeing adds up and makes scientific sense or not. And then building on it. And if it interests you, of course, you can always go in deeper. Chemical engineers, I find are T-shaped people. They can be quite deep as they need to be, but they've got very broad shoulders. My shoulders are not physically broad, of course, but I do regard myself as T-shaped.

Robin Batterham: 00:06:40 As an undergraduate, I actually took five years to do a four-year engineering degree. These days you call it a gap year, but my gap year was actually working as a, I don't know what you'd call it, a non-qualified researcher in chemistry and helping the late Ian Ritchie, wonderful chemical engineer, and professor of chemistry. Over in Murdoch or Curtin...Murdoch, I think. He was at Melbourne Uni at the time, and we were looking at intermetallic compounds and I found this more interesting than doing a third year of chemical engineering, I might add, at the time. I was starting to get a bit bored with chemical engineering at that stage. So got into these intermetallic compounds and I wanted to make a Silicon carbon compound and the way to do it ended up using very, very high temperatures. There was no furnace that could get up to those temperatures in chemistry, but CSIRO had a furnace that could go to near the temperatures we wanted. It had a hydrogen atmosphere, so, you know, reducing atmosphere. So the wires and the furnace didn't just burn up and all this sort of thing. And I managed to burn that up, but then I discovered, okay, well, you could do in a...if you levitated this material in a silver boat, which was water-cooled just in case anything touched it because you needed to get it up to about 1200 centigrade before it would start to soften and run together. And then you had to get up to about 1600 centigrade. So, I discovered that CSIRO, which was a division of tribophysics. So, which was on the university at the time had this marvellous RF furnace, an induction furnace with the capacity for what we needed.

Robin Batterham: 00:08:49 So we built the silver boat, built the cooling system and what have you. And I did all this. And then the day came to put it into the furnace, and we cranked up to the power and we sort of

made a tiny little pellet of the stuff. Testing the stuff was entertaining, because I had to do some work that involved using liquid nitrogen for one of the tests that I was doing on it. I was doing this at 2:00 AM in the morning and the dewar that I was pouring out...I mishandled, and it fell onto the floor and immediately flooded the floor in liquid nitrogen. Think about that. What do you do? I jumped up onto a table because you don't want your feet frozen off. And I thought, okay, do I stay here till someone comes in in the morning, because this is before the days of iPhones but the amount of nitrogen that's boiling off from all this liquid nitrogen on the floor will slowly fill the room, so I'll asphyxiate.

Robin Batterham: 00:09:47 Or do I try and rush for the door? In which case my feet will be frozen, and I'll lose my feet as a minimum. What do I do? And I decided, of course, this is...these are the two extremes. Let me pick a point where I think there's still oxygen that I'm breathing, not enough liquid nitrogen on the floor to be damaging, because it made a fog, of course so I didn't know how deep it was. So, I started poking things down into it and seeing how the ends froze off. Eventually I got out safely, but you know, these days.... health and safety? I got out, you know, about 4:00 AM. The next day I was back at CSIRO, and I decided, well, I could make a lot more of this stuff now I know how to do it. So, we cranked up the power and from an effect that, I'm not quite sure how we managed to do it, but we created a plasma, which is not good news because of conduction effects and that not only blew up the RF furnace, it took the power supply for the whole building out.

Robin Batterham: 00:11:00 So having wrecked furnaces in chemistry, CSIRO, and then their prize RF furnace et cetera. and we didn't get a publishable paper out of it that after all...

Robyn Williams: 00:11:14 A dangerous young man! Now, it was a story way back that many Australian scientists would naturally go abroad, and MacFarlane Burnet was one of the first actually to turn that around. He went abroad certainly and did wonderful work, but then came back and did his main research and activities in Melbourne, of course, in a way that helped establish the tradition, which you enjoyed of a flourishing of Australian science. What did you do? You went to Britain, but only for brief time?

Robin Batterham: 00:11:51 Well, it was only for two years and I must say that what brought me back was as much to do with family reasons as any other. At the end of my postdoc, I was offered a very reasonable position and the decision was really because we had two young children at the time and the elder of the two was heading towards kindergarten and the decision was, well, do you want them to grow up as English children, or Australian children. Now, to me that actually didn't matter much. I saw nothing wrong with English children. I see nothing wrong with Australian children but to my wife at the time, that was very important. She wanted them to grow up in Australia with access to the family, the wider family. So, I looked around for a job in Australia and CSIRO were generous enough to employ me and back we came, but one could have stayed in England.

Robin Batterham: 00:13:05 So it was as much a domestic choice as anything else. But in coming back, I wasn't the slightest bit worried that there would be really satisfying and challenging work to do. I had worked in vacation jobs in an oil refinery, in a fertilizer factory. I'd worked as a labourer chopping wood in an army kitchen, I might add. I worked also at CSIRO, and I saw the spark that was there to look at things from a fairly fundamental level, understand them and come up with something that was far better and appropriate for Australia. And that attracted me. So, I was delighted to pick up a job with CSIRO.

Robyn Williams: 00:13:53 Yes, it's interesting, you bounce back. During the war, of course, when the tyranny of distance meant that Australia was forced to do its own innovation and its own research and found it could do it very, very well. But then after the war, everyone said, well, we're back in touch now, so let's stop. But there's something that happened that got this sort of momentum going now, you at CSIRO became a leader of say, 240 people eventually when you became chief of the division. Where did the understanding of the nature of leadership come in? Because you've been a leader all your life?

Robin Batterham: 00:14:30 I think leadership is something which can be hotly debated, and as to where it came in. To me, the leadership has just got some rather simple principles. The rubber band principle, for example, if you consider yourself the leader on one end of the rubber band and a group of people who you're working with are on the other end of the rubber band. Go out too far in front and the rubber band breaks, because it's just not credible and your

personal authority disappears and can disappear quite rapidly. Be too close to the people, then surprise, surprise, nothing much happens. They just wander around doing whatever they want to do anyway. So getting that tension right is a very obvious thing, you know, when you're having impact. I used to in CSIRO play a rather naughty trick, which was to try and teach people.

Robin Batterham: 00:15:33 This was a bit of leadership and part of my learning curve, you wouldn't be allowed to do these things these days I might add, I do admit that. I was upset by the way, people were too bureaucratic, by the way they were so obsessed with whether they got a double increment or not, and who got a double increment. And whether that was a more worthy case than theirs, and so on. The way they kept their ideas to themselves, rather than sharing them around. In a research environment an idea shared is always an idea enhanced, or shown to be not worthy and discarded, I might add. So never hold onto your ideas, I think that's nonsense. So, I used a bit of a trick, which was for the annual Christmas party at the CSIRO division the research leaders were given an option.

Robin Batterham: 00:16:35 They could get a brown paper envelope, first thing in the morning which contained a field of endeavour when they opened it up, and it wasn't their own field of endeavour. And they had to have written the outline of a provisional patent in that area by lunchtime, which was when the barbecue was, or they couldn't come to the barbecue, or they could come over to my pre-lunchtime recital in the Blackwood Hall, which would be largely Bach I might add, of course, on the wonderful Arhend organ there. And then that would allow them admittance. So, if they wanted to come to the Christmas barbecue with the rest of the team, they had two options. Now, some of them chose the envelope. One of the provisional patents was so good we followed up on it, and this is just out of the head for heaven's sake.

Robin Batterham: 00:17:28 It turned out to be not, let me just say not bad. I don't want to incriminate the person concerned because when we took out the provisional, the amount of experimental work that was done to justify it was a little less than what I would regard as satisfactory in the normal range of things. So this leadership thing I'd always been given opportunities. Sometimes my impact caused ripples. A Director of one of the institutes of

CSIRO gave me the task of coordinating work right across CSIRO in the iron ore area. And at the annual review of all of the leaders in that area. I wouldn't do it nowadays. I carved one of them up for just wasting people's time with the technical direction they were heading. It was a black box approach when there were no fundamentals in it, no furthering of the understanding, just a numerical kick this in the direction of west and it will head in the direction of west type work.

Robin Batterham: 00:18:40 This was seen that my approach, and I remember the words to this day, was like a footballer up before a tribunal for some terrible act and such footballers tend to answer the tribunal in a rather rude way and it was seen that my insouciance matched that of a VFL or to be precise AFL these days, tribunal witness. And at the time I thought, well, not really. I was just calling it as it was. What's the problem? And that continued. I've never been afraid to hold back on, putting down on the table what I think is right. When I was appointed Chief of Division, the Chair of CSIRO invited me to a lunch with the board. So, I'd already been appointed, it wasn't a final interview.

Robin Batterham: 00:19:42 And the board gave me a hard time for not doing enough basic science and running, to quote their words, a panel beating shop. Now, in fact, we were publishing in reputable journals, not quite as much as some of the other divisions I admit, but we were pulling in funding for the work that those publications underpinned at a considerably higher level than any other part of CSIRO. I'm not going to talk about the figures, because it would just sound like boasting, but with one division pulling in almost as much as the rest of CSIRO combined. I rebutted this criticism rather strongly, probably with insouciance and this person lost their cool, which is a bit unusual at a board lunch and said, Dr. Batterham, you should be taken out and crucified not with one nail in the hand, but with two and I just calmly said, well, that'd be useless because you actually don't put the nails through the hand. They just pull out with the weight of the body. It doesn't matter how many nails you use; you only need one nail and you put it through the wrist. Dead silence, so...

Robyn Williams: 00:20:56 I could imagine. A diplomat, but only just. What I would also like to explore necessarily in CSIRO, of course, there's a link with industry. What have you found to be the differences either in diplomacy or in communication? Dealing with bright ideas between the scientists you're talking to and the people in

business who've got to make decisions in a much shorter time worth a lot of money?

Robin Batterham: 00:21:28 Robyn, you've pinpointed here, a challenge that this country has faced, at least since post-World War II. And it manifests itself in all sorts of ways. For example, our publication rates in reputable scientific journals are often quoted as being two to three times higher than you would expect based on our population. And yet our patenting rate or our uptake of innovation is seen as being much further down the scale. And this is a story that hasn't changed in 60 to 80 years, and so you have to look at this and say, what's going on here? Well, on the one hand you can argue, well, this is perhaps because we can afford to be like that. We have very profitable industries. They keep our balance of payments in the right direction. We've got an economy that ticks over on the basis of that, to this add tourism and bringing in students when you don't have COVID et cetera. You look at all this and say, we can afford to make those choices.

Robin Batterham: 00:22:45 It's actually not such a bad thing. That's one view of it. The other is that for many years, there's been a certain element of, I would call it intellectual snobbery around. That pushing back the frontiers of knowledge and becoming a high sci...these days, high sci author or our laudable examples of Nobel Laureates is more worthy than getting the production of iron ore on a ship loader up from 12,000 ton an hour to 15,000 ton an hour in an industry that exports a billion tons a year at a price anywhere, well I mean currently it's below a hundred dollars a ton, but it has paid up to twice that level and higher. This is Australia's largest industry. So, this intellectual snobbery has been well known. The clash of cultures in amongst other things, and I look at that and say, no, that is fundamentally very, very wrong because if you're working in science and you discover something new and you can publish it and have your peers review it and be well-pleased, you have achieved something.

Robin Batterham: 00:24:07 If you were working on an industrial challenge, and you don't increase the ship loading rate from 10 or 12, up to 12 to 15, you have failed. Now you might have ended up discovering that the frequency of particles bouncing on the screen, which is a part of the core of what the ship loading rate is going to be, a kangarooing effect can be changed by putting even more on the screen, which holds them down and stops the kangaroos bouncing too high. And, that's really interesting physics I might

add, and there are a few engineering details as to how you implemented it. So, you could still get something to publish out of it that was actually just as highly publishable and citable as somebody working in a standalone field. I look at it and say, there are various elements to this, not the least of which is that, not all of us have figured out that knocking over technical challenges by getting into the fundamentals 1. Is great fun. 2. Keeps the industry people happy because you're doing things for them, and 3. Still advances the disciplines.

Robyn Williams: 00:25:32 Yes.

Robin Batterham: 00:25:32 I guess I say, what's the problem?

Robyn Williams: 00:25:36 Indeed, but what you're doing there, there are several themes in your work. One of them is scaling up and you talk about getting more of the tonnages on the ship, but you can do it in two ways. Either you can just say, well, there's plenty of iron in that ore. Or you could say there are ways in which, and they're doing this at Centers of Excellence say in Newcastle, where you use less water, you use more cunning to get the sufficient that's required out of the ore before you start shifting things. In other words, you've got a cunning way of combining both the scientific principles and the more brilliant engineering up-to-datedness....finesse.

Robin Batterham: 00:26:26 This is absolutely right. The notion that there are always smarter ways of doing things is a very powerful one. Now, here you run into a bit of economic theory which puts an interesting turn onto this. Let's stay with the iron ore, so you're pouring something out the door at 10,000 ton an hour, and that's, you know, at a hundred dollars a ton. Let's keep the prices down low, that's a million an hour. Now you look at the cost of making some small improvement and the risk of it failing. And you say, look, I'll just keep on at a million an hour, thank you very much. That's putting 750,000 in the bank, clear profit. Not in these days terms I might add, but back in the seventies - yes, that was about the sort of numbers. Well, in the seventies it was $40 a ton but I think cost of production at the time was probably eight to $10 a ton. So, tons out the door, beat improvements and beat them quite solidly because the risk of failing on the improvement is finite. No innovation can be guaranteed. Changing something cannot be guaranteed to improve it, and even in the work that I referred to, the screening work - it did

actually cost about three days of production, because when we got the rate up the conveyor belt that the iron ore went on, which was a kilometre or two long heading out to the ship loader, was actually getting more sideways force on it from the higher flow of ore, and so it tracked slightly to the right as it was heading on out. That was nothing, but eventually it tracked further and further, and eventually some alarms went off that indicated side belt problems.

Robin Batterham: 00:28:42 The operators ignored those alarms on the basis that they had never had a side belt alarm. They saw no reason why they should be getting one. They didn't get off their backside, jump into a truck, go out and investigate it. You know, half a kilometre away from the control room, and the control room was up on a tower, beautiful views and all that sort of thing. So, the net of that was about 200 meters of the belt ran off sideways. Now you can't come along and just pick it up. There are tons and tons of material. You've got to send people in with shovels and wheelbarrows, and then eventually front-end loaders. Scoop it all up, clear the belt off, then bring in cranes to lift the thing back on gently enough so that you can run it forward and clear the belt. This was three days or so.

Robin Batterham: 00:29:32 So the experiment that we did, succeeded in getting the tonnage up, but it failed if you look at it and say, they lost three days production. Now that was an enormous amount of money. Now they put in drop plates to break the momentum of the ore falling down, which I should have thought of and could have thought of by the way, if I'd really spent enough time on it. But I was so enthused with the notion that, I can see how to get the shipping rate up, let's go guys! And they believed me. So sometimes you're going to be lucky, they continued to believe me...

Robyn Williams: 00:30:09 Well, let's get you to Rio Tinto and CRA [Conzinc Riotinto of Australia] where you're eventually Chief Scientists there. Were you dealing more or less directly with management and the business people? Were you as much involved with the engineers and the people on the ground as you had been before?

Robin Batterham: 00:30:27 The positions that I had in CRA and then as it became Rio Tinto, where at a fairly senior management level and as such one was dealing with one's peers at that level for an awful lot of the

time. The people that reported to me when they had corporate laboratories, their advanced technology development laboratories, were of course at a lower level that they had to be dealing with the operators of plants, the general managers of plants, the technical advisors, and so on, every day. And it seemed to me that whilst I could talk with my peers and the group executives and occasionally with the board, and certainly with the board of some of the subsidiaries, like Comalco, pretty regularly, that was one level of communication, but you have to have the people who are doing the things actually out there talking with those who you're trying to help. That's essential.

Robin Batterham: 00:31:40 So you can't escape that. You can't escape that in CSIRO either, or universities for that matter. If you want to make a change, you have to be able to spend the time, and not just time, but understand what's needed and see how you can fit in and work with it. I find it appalling that people will take money for a project to do with an industry supported project and then in effect hardly communicate or look at what the partner wants to do, that's paying for the work, in anything other than whatever the mandatory reporting time is. That really is not a formula for long-term success. And then whether you're starting up and spinning stuff off, or whether you're working from within Rio Tinto with existing business units, one has got to remember the formula that making innovation and making advances in science, I would argue is path dependent. So that if you get on well with people and you have successful results, surprise, surprise your path forward is a lot easier than if the only time they see results is when they almost force it out of you.

Robyn Williams: 00:33:10 How did you deal then with various aspects of environmental consideration? Which of course with Rio, as well as various other mining mineral industries is, especially in recent times, has been a fairly bumpy ride. Did they consult you?

Robin Batterham: 00:33:25 It's interesting. This has always been on the agenda and there's a few ways you can look at it. Personally, I acknowledge that I have a personal position, which is a little bit irreconcilable in that it's got some contradictions in it. I used to work pretty frequently up in the Pilbara. So frequently I might add, this was back in the seventies that the company actually gave me a house because it was cheaper for them than paying the hotel bills and so on. And also, it meant that some members of my team who were there much longer term could be there. So, I'd

fly up sometimes twice a month and stay there for a few days. And if I had a weekend, we would always go out walking, whether it was inland, whether it was going out on the Burrup Peninsula.

Robin Batterham: 00:34:23 I can remember trying to get to the confluence of the Hancock Gorge, and the Witternoon Gorge, and the Joffre Gorge, which all come in together in one place. It's sort of impossible to get to, and we had three or four attempts because at that stage, there were hardly any tourists, et cetera. It wasn't easy to access. And we eventually got there, and I can recall the exaltation and how great I felt. We were down at the bottom of what is quite a steep gorge, where the other three come in and we heard voices and I thought, oh. You sometimes get people up the top, and if so, you've got to watch it because they'll inevitably throw stones. So, we tucked ourselves in against the wall and then I thought, they're actually coming up Witternoon Gorge.

Robin Batterham: 00:35:16 This was a bunch of people from Dampier, from one of the youth clubs. And they'd brought up inflatable rafts to paddle across stretches of water, then walk along the base and they'd actually walked up 15 kilometres or so in Pilbara type heat, I might add. And their idea was that they were going to climb out through Hancock Gorge. Well, that's not easy because it's got an overhanging lip in it. And we'd had several attempts to figure out a way without equipment, how you could do this, get down and get back up again, getting down was easy. It just jumped off and fell into the water. So, we had to help these guys climb up. Fortunately, we bought a rope with us and a log that we'd found further up the gorge, and we could wedge it across, and we can actually, actually provide a climbing rope for them.

Robin Batterham: 00:36:07 I was thinking at the time, how outrageous it was, when having carted this log for a kilometre or so along the gorge and with a rope, which was out just in case, though it tuned out it was need. When we wedged this log across a couple of more than cracks, but clefts in the rock face. There was a piton that had been banged in where somebody had followed exactly the route that we were and had just used technical climbing. How outrageous! And I thought this is a pristine environment. What are people doing? Banging pitons into the rock. This was before the LNG train was built, we used to walk out on the Burrup peninsula and just rejoice in the environment that it was the

pristine state of it, and we had a couple of favourite spots. I recall visiting one, one time and thinking, this is where they're going to bring the LNG in. The bastards! How can they do that?

Robin Batterham: 00:37:19 Now, the only reason I was there, was because Hamersley Iron was collaborating with us and we're working on technical problems, like improving the ship loader rate . And they had massively changed the environment. Of course, when they came and yet I had this unreasonable reaction that how dare you touch a pristine environment like this? And I think I carry this dichotomy of view, but I've long since rationalized it by saying, if you were on the industry side and the investment side, you always have two points that are extreme. One, do something which is against the law and go to jail. That's clearly a no-no, although in places around the world, of course, environmental degradation, just staying with environment, is appalling and illegal. However, that should be one limit in your thinking that says, I must at least stick by whatever the regulations are...

Robin Batterham: 00:38:31 And by the way, regulations have a habit of getting tougher and tougher. Why? Because our ability to detect things is now for many things in the parts per billion, not parts per million or parts per thousand. So, regulations often tend to follow detection limits, but that's another story. That's one point. Now out on the other is to say we will bankrupt the company ensuring that our footprint is absolutely minimized. Just simply as much as you can and the cost of doing that will bankrupt the company. So, you have to come to a compromise position in good faith that says we can't avoid having some impact, but can we make the impact at a point where the options for the future are maintained. And, mining can't be totally sustainable, that's nonsense, you're digging up a resource for heaven's sake...that resource is not there as an option in the future, but you do have to think about, well, if you're digging a pit, what's it going to look like when you're finished. Because the valuable that you're taking out...remember when you break rock, you end up with a volume that is about 30% greater. So, what are you going to do? Are you going to backfill the pit? Have you figured that one out? What happens to the water table? What happens to some obscure life forms that might've been living in ancient water that you're going to end their lives?

Robyn Williams: 00:40:11 Yes, but if I may just say that sometimes the signals are so strong, you mentioned Witternoon just now, obviously that was where lots of asbestos mining was going on. And even 50 years ago, it's perfectly plain that asbestos was becoming a massive problem. And of course, there was, involving Rio Tinto, explosions involved more recently with the caves involving Indigenous arts. You know, somehow, you've got to perceive, especially in your position as Chief Scientist. You warn them and say, this cannot go on?

Robin Batterham: 00:40:50 I think that deciding on that curve from hopeless on the left of the curve to hopeless on the right, deciding where you sit has to be a very communal decision. It is not just the company and its direct stakeholders. There can be lots of stakeholders involved and the chances of coming up with decisions to please everyone, of course, are zero, by the way. I think in almost all cases, one has to accept that as a reality, and it can be a long-time negotiating positions. I do look at the way social media and a lack of facts and misinformation swings debates these days and say, coming to a position that makes sense to most people is actually a lot tougher than it was when I was in the industry. And that's courtesy largely I think it's, as I say, misinformation through social media. The social media side, I say is good in that more people now can be involved in these decisions that have to be made, but it's tough.

Robyn Williams: 00:42:14 Let me ask you now about two aspects of your research, one starting with zinc, and then green steel. Some of your ideas there, starting with zinc.

Robin Batterham: 00:42:29 The zinc one was interesting up in the north of Queensland. There are some deposits that are extremely fine grained and by fine-grained, I mean, liberation size for the valuable mineral of around seven or eight microns. And whilst this is nothing in the industrial materials area, for example, pigments for paint are ground down to that sort of size. In the minerals for metals, it's pretty unusual to have to come down much below a hundred-micron, 50 micron or so. To come down an order of magnitude more than that to liberate the valuable mineral is really a challenge because it costs you energy to grind something up just to liberate a mineral. So, it's interesting that there was a [similar fine grained] deposit at McArthur River that I recall when I was working in the CSIRO. Mt Isa Mines owned it at that time, and they brought [the problem] to CSIRO and the world

actually to say, can you figure out a way to liberate the valuable minerals so that this becomes an economic deposit? There was an awful lot [of this fine-grained mineral].

Robin Batterham: 00:43:44 And that was essentially 40 years, a 40-year journey for [Mt Isa Mines] to come up with a way of successfully liberating the minerals in their case, largely zinc and lead. In some way, CRA as it was then was a bit luckier in that the deposit they found was, was similarly fine grained, and not all that far away I might add, was almost entirely a zinc [mineral]. And it was zinc that didn't have any iron in it and iron is one of the contaminants in zinc concentrates that ends up as a nasty and is pretty hard to deal with. It used to be dumped in the ocean, I might add. That's stopped these days. This fine grain zinc, we managed through ultra-fine grinding and then finding almost miraculously that flotation worked to separate the zinc from the other minerals was actually pretty straight ahead. [This was a breakthrough in fine particle flotation].

Robin Batterham: 00:44:47 So we ended up with something which was developed in two years, compared with 40 years for McArthur River. The project was highly successful economically. There was another technical breakthrough in [the project]. Zinc concentrate is first of all roasted in a flash roaster to turn it into zinc oxide, which is then leached with acid. And if you put 10 microns [concentrate] into an up flowing current of hot gas, it's just going to blow out the spout. It has to be about a hundred micron. That's what the [roasters] are designed for and what we found, it was just so simple, that if we just trickled water on the feed belt to this flash smelter, it caused enough agglomeration that the particles stuck together for long enough that they fused before being oxidized. So, they were the equivalent of a beautiful hundred-micron material. So, there were these series of breakthroughs that got this [project] through in just two years.

Robin Batterham: 00:45:56 And I've had some tough things to do in my life. One of them was to tell the team who had worked...certainly quite often seven days a week, because we were under enormous pressure. This was the only significant project that CRA had on the books at the time. So, there was the CEO requesting fortnightly updates of progress. Now in the world of science and technology, you don't make progress on a fortnightly basis. Well, if you do, it can often be in the wrong direction etcetera, and we tested their patience. And, through my group executives

at the time, who was just an absolute pillar of strength, and buffered some of this for me, and I pay tribute to John Innes' leadership there. We were able to shield the team from a lot of that pressure, but the disappointing thing was when we got it through and it was piloted onsite, et cetera, and there were many tales one could tell about that. It was then sold to another company because the NPV, the net present value of selling it at that stage was higher than if Rio Tinto had owned and operated it itself because the low iron content meant it was particularly valuable to smelters who were running out of places to store their jarosite residues.

Robin Batterham: 00:47:36 And I had to tell the team, gee, thanks guys. You know, world-class, absolute show beater. You've done in two years, what others took 40 years to do. And it's an absolute success, and the company has just sold it.

Robyn Williams: 00:47:49 Okay. The story of green steel and Veena Sahajwalla from the University of New South Wales has been recognized as bringing that forward as well. Do you match in approach?

Robin Batterham: 00:48:03 I've great respect for Veena. She worked with me at CSIRO a long time ago. I've great respect for her work. There are many alternatives [for green steel] and I gave a talk recently at the Iron Ore [World] Congress. I think the world has become a bit enamoured with the hydrogen route, which is make hydrogen from electrolysis and then use that for direct reduction. And that's fine, it will work. But if you look at the international energy agency's roadmap for the iron and steel industry, you'll see that by 2050, the industry is still nowhere near zero emission. It's at least 2070 in their estimates. And that is using a very aggressive investment in new technology and new investment. So that's not quite the rosy picture that one hears, when one hears the stories that we're going hydrogen, that's all going to happen.

Robin Batterham: 00:49:20 And yes, it will. I might add, but globally, that's still a slow process of change as with any capital intense industry. You can argue that's the case. So, we're looking at alternatives to the hydrogen route and at this stage until the second patent is lodged and the public announcement is made of the funding. I can't say much more than that. Other than saying that there are two or three other routes that are around the world being looked at. One of them is happening here at Melbourne

University. One of them is happening at MIT. The MIT one is a very high temperature direct electrolysis and having spent years on direct smelting molten iron, [any system] with FeO dissolved in it at 1400 plus centigrade is quite an engineering challenge, but one which the iron and steel industry actually well knows how to handle. So, there are some interesting developments there at the moment, some of them are wrapped up and I would look at this on a global basis and say fine. It is always good to have alternatives there, and we will see how they develop. This is a watch this space area Robyn and I hope we can talk about it a bit more sometime soon.

Robyn Williams: 00:50:52 We shall. Now let's talk about your being a Chief Scientist. And again, I mentioned Bob May. He was Chief Scientist in Britain, and when he was appointed, several extraordinary things happened at once to challenge him almost to the limit. And one of them was mad cow. When you were appointed, was there anything like that to overwhelm you?

Robin Batterham: 00:51:15 I don't think there was. Bob May was, I acknowledge as an extraordinary great person, both in terms of fundamental contributions to science and their application and having a very smart head on the shoulders. I got on very well with Bob May. Both of us, of course looked, at that stage when we were both chief scientists pretty similar. [I had far more hair than I have now and curly, as did he] also both of us sort of reasonably lightweight, scrawny looking people. Not totally similar in face, but similar enough that if people didn't know either of us, they, and we didn't introduce ourselves, they mightn't be quite sure who was who. And I do recall giving a press interview with Bob, a joint press interview on one occasion after the World Chemical Engineering Congress. And we'd both given keynote papers and then gave a joint press interview afterwards. And the first question was fired at me but answered by Bob May.[Missing section here]

Robin Batterham: 00:53:15 Thereafter, we continued for the rest of the interview, including when it was for Bob May then I would answer and vice-versa. And we both walked off stage trying to keep a straight face. Of course, I might add, no harm was done. We didn't make any claims that were untoward. They were fairly straight-ahead questions, and both of us well capable of answering them all. But I tell that little tale just on the basis that he was actually full of life, of course, always ready to talk and swap notes. And

fortunately, I just didn't have a mad cow type catastrophe on my hand at the time. The carbon capture and storage did blow up in that it was seen [that I was biased] in pushing carbon capture and storage, which is still I think, got a long way to go in terms of the tonnage and making it actually happen. Technically it's been shown that it's all doable and appropriate. In pushing [carbon capture and storage] I was seen as having a conflict of interest and that caused quite a bit of pain within government. But as it turned out, there was certainly no conflict of interest and the...

Robyn Williams: 00:54:43 By the way, if I can just interrupt there. Carbon capture and storage still has a long way to go in, assuming we've got 10 years, do you think it'll make it?

Robin Batterham: 00:54:52 I think carbon capture and storage is in an interesting position. We've got a project going on here, a joint effort between this university, Princeton, University of Queensland, and the Nous Group. And it's looking at a similar approach to what Princeton did for north America. The so-called Net Zero America study, and the Net Zero America study is really quite stunning because it takes what all the demand is and reasonable projections on population, energy demands, transport demands, and so forth, and then brings in on the supply side, whatever is the most economic at the time. And it does this for different scenarios, high electrification, or not so high electrification. All renewables or constrained renewables. In other words, you can only build renewables at say one and a half or more times, the rate that you have ever succeeded, or any country has ever succeeded in putting renewables in.

Robin Batterham: 00:56:00 And then it goes into all this detailed modelling of saying, well, there's an awful lot of land that you can't just put wind towers on or solar panels. It might be too steep, or it might be land, which is very valuable for agriculture. And you can't just turn around, say for offsets, and take out your arable land and turn it all over to forestry. Just because you want to sell the offsets, you then don't have the food to eat. And so, it goes on. So, in down-scaling, it not only included everything rather than just looking at one particular sector. It included everything and it did all this downscaling, of going right down to what I call postcode level of what you can put in and what you can't. And then you bring the thing in, on an economic basis. And the results are just to me, staggering, in that the amount of renewables that you've

got to put in is actually fairly mind-boggling and for Australia, which is where we're doing this modelling now the challenge is not so much getting Australia to zero. That's quite doable, I think, but our exports at the moment have so much in the way of direct emissions from the people who use them.

Robin Batterham: 00:57:24 So-Called tier three emissions. That if the world is going to decarbonize, it's not going to take our products unless we do some of the decarbonizing. So that's where you then have to start looking at carbon capture and storage and saying, do we have the capacity? Not for what we might need just in Australia to get to net zero, but for all of the emissions associated with our exports. And I've got to tell you on that score, there are some particularly in the geological sciences, who would say, yes, we have. There would be others who say, you're just looking for an excuse to keep on doing what you're doing, and that's not the way of the future.

Robin Batterham: 00:58:15 And by the way, I agree. Totally. but you might need CCS for some things that are really hard to decarbonize, I might add, like cement production and so on. Now, the difficulty is that there is a difference between the number that some people say we are capable of for CCS and the numbers that could be achieved when you talk to people who actually own some of these properties and who are trying to make CCS happen, the numbers are not as great as what some of the geoscientists argue. And I can see the reason why. It's not until you actually poke wells in the ground and test flow rates and test where the material goes to that you know where you stand. Rio Tinto did a joint venture with BP, and they were looking globally at opportunities for CCS.

Robin Batterham: 00:59:16 And they looked at one off the coast of Fremantle. And the idea was from the BP refinery, you would take the hard to utilize materials from the crude distillation unit. It's sort of only good for asphalt on the roads, and there's a limit to the number of roads you can build even in Western Australia. You would gasifier it, pull off the hydrogen and you would take the carbon dioxide and put it into a geological formation, so you'd end up with a valuable product - hydrogen in this case, which you can use for upgrading the transport fuels to a higher octane number, and CO2 to be buried. All of this proceeded, it looked terrific on paper, and then they started drilling holes into the formations and started doing a bit of test work and they found

that formation A actually had some pretty big connection to Formation B to Formation C.

Robin Batterham: 01:00:20 And all of a sudden you were under Rottnest Island, and would you really want to be gassing the quokkas with CO2? And the point about this is the doing the detailed geology indicated that what was an apparently very promising reserves from large scale geology. When you got down to fine scale, didn't add up the way you expected. So until a lot more geological testing is done, we're in a bit of a catch 22 here. I would argue that until a lot more CCS is tried, we don't actually know what the capacities are. I have no doubt that you can poke CO2 down one and a half, two kilometres and have it stay there for heaven's sake. The natural gas that was in that reservoir, that you've extracted all the oil has been there for a long time. Why won't the CO2 be there for a long time? And, you know, oh because it will leak back up the well. Well, not if you plug it properly.

Robyn Williams: 01:01:24 Interesting, yep. And of course, this relates very much to the carbon work you're doing at the moment as well, advising on how we can do agriculture in different ways. So that carbon goes into the soil. And again, this argument about how much can go there, how you measure it and how it stays there? Is that what we're working on at the moment?

Robin Batterham: 01:01:43 I think the carbon in soils story is a really interesting one. It's featured as part of Australia's technology roadmap that it's got quite some potential. You're spot on. The opinions in this area really vary from stridently against the notion to vociferously arguing the case for it. Both have a reasonable position. The reason that you get this disparity in what I'd call the science is that carbon in soils per se, is a highly variable measurement. Firstly, in the upper layers, it goes up and down depending on the crops, the weather, et cetera, it's highly variable. So that's temporal. The deeper you go, the more constant it is, like temperature I might add. So that's, that part's fine. So, we've got this temporal variability and Australia being a land of droughts and flooded plains, et cetera.

Robin Batterham: 01:02:58 And with the likelihood that some would argue that we're going to see more variable rainfall than what we've had before. This isn't a good news story for carbon in soils, but then on the other hand, if we think about deeper rooted species and this might mean changing agricultural practices so that we go more for

perennials, that we go for deeper rooted species, that we go for riparian agriculture, with rows of trees, with windbreaks et cetera. You can envisage 10 to 20% of good quality arable land being given over to planting trees or deep-rooted species. So, I might add, and the benefits of the greater water retention actually meaning...and less agricultural chemicals needed, I might add because you have more birds get rid of more insects, and so it goes on. You could end up with a win-win here, but as to the question of how much the jury is out, it's as simple as that, there are opinions, there is the anecdotal evidence, but when you get into the anecdotal evidence, was it all measured to the standards that would pass peer reviewed science?

Robin Batterham: 01:04:17 And the answer is no, by and large. Are we just going to take satellite imagery and interpret the three colour or whatever, or hyperspectral and say, well, look, we know how much plant protein there is there and it's going up, therefore the soil carbon is going up? No, you just can't do that. We have to do the work to crack this particular challenge. And I think when we do, if we can deliver a low-cost method, much, much lower cost method of accurately forward predicting what soil carbon is on an annual basis, then the benefits are going to write the equation themselves because there will be considerable benefits, even if we're hitting rougher climate climatic conditions.

Robyn Williams: 01:05:12 Now I'd like to ask you a question about the future, your discussion over this past hour has been to do with so many different aspects of minerals, geology, the exploitation of resources and so on. And so, it comes to a surprise to many of us that there were departments of geology in Australia, at universities are being closed down and that geoscience has been diminished. How is it when there's so clearly an importance and also a heritage in this regard that such things are going on and if I reappointed you as chief scientist, what would you do about it?

Robin Batterham: 01:05:50 This one is interesting, what do students choose to study at university? This is a really interesting question. I'm not going to duck it; I will make a few comments on it. Equally, what graduates are employable is another part of the answer to this question. And we can't avoid the fact that as students go through school, they're very effected by their teachers and what their teachers think and the directions that they're pushing them or encouraging them. So, when you take the totality of

this and you come to a position that says mining and anything associated with it is intrinsically bad, look at all the problems it's caused, and it does cause problems. For heaven's sake, you've mentioned some of them earlier on. If I got into the business of tailings, this ultra-fine material, the waste that remains after you've extracted the valuable mineral, at the moment in the world of order one major tailings facility collapses every year.

Robin Batterham: 01:07:07 And there's quite a few mishaps. And we're well aware that some of these mishaps have caused great environmental concern. Cyanide residues heading off down the stream for a hundred kilometres or so in a European country or Eastern European country. And then let me not go into detail, iron ore tailings, letting go and wiping out a couple of hundred people, let alone decimating a productive valley, and so on. This sort of thing is still going on. So, is it a surprise then that teachers and students at schools see anything associated with mining to be not where we want to be? We want to be in a circular economy and I'm very supportive of that, I might add. A circular economy can only work by the way if you've got energy input to it. So, one should also have the discussion about energy before one gets carried away with circular economies, but by any stretch of the imagination, it's going to be 30 to 50 years before the globe gets to the circular economy.

Robin Batterham: 01:08:16 And so you're still going to need primary materials for that period of time. Albeit, in diminishing amounts, but an awful lot of primary materials. So how do we get over this mismatch between how our students perceive the world and how they're educated and the like, and hence the choices they make. And then at the university level, how do you, if you not getting the students applying, these days that means that the department closes, full-stop end of story. Certain aspects can live on as research I might add, providing they're pulling in the research dollars. So, this is a problem which is society wide. Now, if I turn to the university part of it, I think that's fairly easy. Try for, if you want people to do a geology course, try firstly doing world-class research that in and of itself gets a reputation and helps to inspire people, the undergraduates that do come through.

Robin Batterham: 01:09:26 Two, put prerequisites on your course and high levels of performance. So, you don't take an ATAR or its equivalent below 95, and you do require math's, physics, and chemistry, and then see what happens. Physics over in Western Australia, I

can't remember whether it was UWA, or Murdoch or Curtin did just that. And the numbers increased, not decreased. Think about that. Why? Because it was prestigious. It was something you had to be really, really good. And if at the same time you come into a department that's doing world-class research and is getting industry input as well. And that's not too hard to do. You've got the formula at that end; you still have to address the formula through the schools and the wider bit. And I think that has to be by outreach of companies, of universities, reaching out into the school and working with them.

Robin Batterham: 01:10:26 And you can't knock over all schools. You do it by being a little bit selective because there's only 24 hours in the day to do these things. I look at something like the STELR Program that the ATSE started off by Alan Finkel, I might add. Of giving students the equipment and the gear and the curricula and making sure it's within the curricula to teach things about, to teach basic physics and a bit of chemistry I might add within curricula, but very much tailored to renewable energy. That's the sort of outreach program that changes people's attitudes that it's doable. And that it's interesting. So, Robin, it's a long-winded answer. I think one can make a difference here, but the formula is a tough one and it goes against the tide to turn around and say, well, we're in danger of being shut down because we're not getting enough students instead of the race to the bottom - we'll take anyone that can even spell a geology. And by the way, it's G E O it's not G E E et cetera. No, no try. Only taking students that have a 95 ATAR.

Robyn Williams: 01:11:42 What else are you working on? We've, we've gone through a huge list and lots of it is still being maintained by your extraordinary mind and activity. What would you like to mention at this point?

Robin Batterham: 01:11:55 Yeah, we've covered a lot of ground. I find the only limit to ideas and applying them and finding worthwhile things to do, whether it's in the education field. Whether it's in the research or the like are the hours in the day and the fact that I might add, you've got to work with people. One just doesn't have, these days the notion that as an individual, you can go off and invent a green steel process. You've got to do that with colleagues. So, you've got to be able to work with teams and so on. So, my perhaps only complaint in life is that nobody has invented the 25 hour day. It's really quite outrageous. There's such a need for

it, and it's just not happening. So, and you can look at your sort of personal life and say, you still have to balance your personal interests here.

Robin Batterham: 01:12:51 So there's many things that I am working on at the moment and it's really that my colleagues are working on and they are generous enough to let me slip in and throw in a few ideas and then work with them. I'd point to the work of Professor Antoinette Tordesillas who has got a wonderful approach of looking at how shear bands develop in particulate solid. So, if you've got a, a column of sand, for example, a now compress it and it's contained in a column where it...and it doesn't matter whether it's concrete or sand or whatever, as long as it's ultimately a particulate. The prediction of where the failure band will occur, she can do. And she does it by a combination of watching what all the movement is at the individual grain level, and then forward predicting how the whole is going to move.

Robin Batterham: 01:13:48 And this is not massive computing of taking every single grain and saying, it's got this force on it. Can it rotate? Can it slip and so on? We don't have the computer strength to do that sort of thing. This is far, far cleverer than that. This is saying, well, you've got two modes of operation here. One of these modes is that it all just sort of sits there when you put a little bit more force on it and it gets a bit excited and the force chain that actually supports the weight is not every single particle, it's chains of particles. And when one of them slips a little bit like a column bending can no longer take its load, other force chains form. So, it's all about, are the force chains staying roughly in the same place? Or is a failure mode where there's going to be catastrophic movement and force chains, just aren't in the picture starting to become evident by the patterns of movement.

Robin Batterham: 01:14:48 And when I looked at her work, I thought this is brilliant because [of what we could do with that approach]. And Rio Tinto had just had a slide in the pit, a one-kilometre-deep pit, and the whole side of one face let go. Disaster! They saw it coming months in advance, I might add, but even the extent of it caught them by surprise. And I thought, Antoinette, your work here is remarkable because if you apply the same logic to an open mine face or a side of a hill that might let go and have a mudslide, that buries a village, or the side of a volcano, that with just a little bit of oomph from underneath might let go. Like, Mount

Stromboli is in Italy et cetera, the same principles are applying. So, we got some information of a collapse of a face of a mining operation.

Robin Batterham: 01:15:53 Such information was a little bit hard to get. We've had to keep it anonymous. I don't think it burned up any friendships, but we certainly weren't able to say what it was that we were looking at. It was an incident where there was an unfortunate slip, nobody was injured, no equipment was lost, et cetera. So, it was just a delay to production. And we had the radar ranging data for every pixel point on this face and the best available technology...and we had about six weeks of data...the best available technology, globally available gave about five false warnings before giving a very clear warning two days before the failure. Antoinette's technique picked up the likelihood of failure on day two and was right.

Robyn Williams: 01:16:39 So you can predict danger in mines and hillsides, in all sorts of circumstances?

Robin Batterham: 01:16:49 Yes. Is the short answer, and I'm currently looking at how we might get funding?

Robin Batterham: 01:16:55 We're talking with the Nepalese government because they have slides coming down the hillsides and wiping out villages in the valleys with unfortunately quite a high incidence. As to how we might get funding to use the Sentinel [satellite data], to ranging to and apply this methodology to it, to actually forward predict to the residents in these valleys when they've got to get the hell out of it. We haven't got funding for that yet, but that's just one example, I could actually give several others. How do you make micro bubbles? If you can figure out how to do that, you can change the economics of wastewater treatment of fermentation processes of a lot of chemical reactions, I might add. There's some brilliant work done by Zimmerman in the UK of using a fluidic oscillator to alter the flow rate of the air, coming up to an orifice where a bubble is going to form and pulsing it at such a rate that only a tiny bubble comes off rather than what you normally get.

Robin Batterham: 01:18:11 This phenomenon by the way that I observed back in my post-doc days anyway. So, it's not new, but the Zimmerman has been out and patented it and good on him and so forth. His approach uses a fluidic oscillator, it's a bit of dog. With due respect to him

in terms of its robustness and operability and so forth. And no doubt you can tune it up. I compliment him on all the work that they've done, but there's smarter ways. I think of doing it, using piezo-electric switching so we can use the basic phenomenon that's there and perhaps generate the pulsing by piezo-electric switching, which you can do at very high frequencies. And you can tune the frequency and you can tune the amplitude and so forth. So, bingo! I think we've got ourselves a microbubble generator. And when there's enough time, we'll go chase some funding to develop that. There are others...

Robyn Williams: 01:19:07 Still going strong! Two final, quick questions. The first is having been a Chief Scientist and still being in touch with politicians, making big decisions. How do you get on with them?

Robin Batterham: 01:19:17 I find politicians an unfairly maligned species. I've had the great privilege of working with a string of politicians and the ongoing privilege of being asked for comment by a range of politicians or coming across them and giving them comment if they want it. So, I still have some regular discourse with politicians, not as much as when I was Chief Scientist. When I was Chief Scientist, I made a point of talking to shadow ministers as well as ministers, caused quite some upset when I first started doing this until people realized, no, he's not giving away party secrets or whatever. He's working on things that need bipartisan support. They're important enough for that. And I still hold to that principle. One certain politician greeted me not all that long ago, Robin! Your video on such and such went viral, blah, blah, blah, and went into a bit of detail on it.

Robin Batterham: 01:20:29 That level of being able to chat and being known, I might add and also respecting their positions on the political scene means that it's fairly easy. And what I've found is that with the politicians that I deal with and continue to deal with is that these are highly intelligent, highly capable people, the pressure they are under never to say the wrong word, always to be able to whiplash the other side, et cetera. The social media, the constant media attention is just something that is almost inhuman. That of course colours some of their behaviour, but to be able to sit down for half an hour or an hour even in some cases, and just simply discuss what's best for Australia and how might you achieve it? That's a great privilege. And the people that I occasionally have the great privilege of talking with, I respect for the intellect that they have and that their hearts

tend to be in the right place, even though they might behave politically from time to time.

Robyn Williams: 01:21:43 Indeed, but you're not set off by those behaviours. You're not getting angry. You're not led by passions. That for instance, going back to Bob May, drove him quite a lot.

Robin Batterham: 01:21:56 I'm driven by the passion of seeing better things happen. And that's my passion. You can say, well, you're just a technical hedonist. You totally enjoy these things when they work and so forth. The answer is Yes, happy to admit that. The world I hope ends up in better place when we as scientists and technologists and engineers get in and improve what we have now, either by inventing the new and seeing it implemented, or simply by improving what's there, there so much that we can do, so much more.

Robyn Williams: 01:22:32 Do you still play music in church?

Robin Batterham: 01:22:35 I gave up my position of 20 years as assistant organist at Scott's church, which in some ways you could argue, well, you're crazy. It's got one of the top organs in the world. I'm an organist. And it is, I would argue it's the best in Australia, but many would argue against me on that one, but I can go into chapter and verse on that. A professional choir, a congregation who are as interested in the ministry of the music as anything else and that I see as very positive. It's pointless making good music if it's not moving people appropriately. And I gave up my position of 20 years there. I still play occasionally there and still do some other work. And one of the elders of the place came up to me at the time and said, Robin why are you retiring? It was sort of what are we doing wrong? Is it the salary? Should we double it? I said, no, I think it's time that somebody else had a go at it. I'm spending less and less time in the country, as it turns out. Then my time commitments were such that it's really not fair. I'm keeping some probably better musician out of a really good job. They should be having the fun. So as simple as that...

Robyn Williams: 01:24:02 Thank you very much indeed, it has been a delight talking to you.

Robin Batterham: 01:24:05 Thank you