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MURRAY R. GRAY

Murray R. Gray, BSc, MEng, PhD has over 25 years of research experience in upgrading of heavy oil and oil sands bitumen. He is currently Director of the Centre for Oil Sands Innovation, Vice-Provost (Academic), and Associate Vice-President (Research) at the University of Alberta. His success in collaborative research with industry on the development of Canada's oil sands has been recognized by numerous awards and prizes including the Centennial Award from the professional engineering association in Alberta (2011), and the Industrial Practice Award of the Canadian Society for Chemical Engineering (2003). In 2005, he was elected a Fellow of the Canadian Academy of Engineering. In 2006, he was awarded a Canada Research Chair and an Industrial Research Chair in Oil Sands Upgrading. Gray obtained his Ph.D. in Chemical Engineering from the California Institute of Technology in 1984. He also holds a M. Eng. degree with a specialization in Petroleum Engineering from the University of Calgary (1980) and a B.Sc. in Chemical Engineering from the University of Toronto (1978).

Date and place of birth (if available):

Date and place of interview: August 8, 2013 at the University of Alberta, Edmonton

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Consent form signed: Yes

Transcript reviewed by subject: Yes

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Interview Duration: 2 hours and 27 minutes

Initials of Interviewer: AD

Last name of subject: GRAY

AD: My name is Adriana Davies. I'm a Researcher/Interviewer for the Petroleum History Society Oil Sands Oral History Project, and it is August the 8th and it's 1:30 p.m. and I'm in one of the University of Alberta's engineering buildings and I'm interviewing Dr. Murray Gray, who is the Director of the Centre for Oil Sands Innovation at the University of Alberta, and I believe Vice-Provost Academic and Associate Vice President Research of the …

GRAY: That's right.

AD: …University of Alberta.

GRAY: Yes.

AD: Murray thanks so much for agreeing to be interviewed.

GRAY: My pleasure.

AD: Now, can we begin by you giving me a summary biography and then we'll drill down and get into …

GRAY: Okay.

AD: …your career as an academic, administrator, researcher, all of those things.

GRAY: Okay. I was born and raised in Toronto and I did my first degree, my Bachelor's degree at the University of Toronto in the mid-to-late 1970s. At that time, energy production was first and foremost in everybody's minds and I actually did an undergraduate research project on oil sands at the University of Toronto. When I graduated, I wanted to get more involved in the energy industry, but there weren't actually that many jobs in the oil sands yet, so I worked with Shell in Calgary in their natural gas department for two years, and then decided I wanted to get more into research and development so I went to the California Institute of Technology in Pasadena, California. I did my PhD; My PhD work was on biomass, a renewable energy source rather than non-renewable, but when I finished there I wanted to start an academic career that was related to energy and oil sands and related issues, and so I joined the University of Alberta. That was in October 1983, so just coming up on 35 years ago.

My initial interests were primarily on upgrading of oil sands and related problems in the area that we call chemical reaction engineering, and that's been my major emphasis ever since. So I've been with the University of Alberta ever since 1983 in different roles: as a professor, as a department chair, as

Dean of Graduate Studies for a time, and currently as a professor and Director of the Centre for Oil Sands Innovation half time, and the other half time as Vice-Provost Academic and Associate Vice-President Research.

AD: Now, I'm, I have to ask that question -- what was your paper at the U of T on oil sands about?

GRAY: Well -- it was an undergraduate thesis and it was with a faculty member called Don Cormack, who was doing work with AOSTRA, Alberta Oil Sands Technology and Research Authority, and he was interested in the problems of in situ combustion of [oil sands] -- and this is a technique that keeps coming and going as a primary production technology for the oil sands, and so in the lab I was working with actual oil sand samples to try and measure how gases would basically spread and diffuse as gas flowed through a packed column of oil sands.

AD: Wow, so that was really a foretaste in a sense. Did you choose the topic yourself or did …

GRAY: It was a negotiation. I spoke to a number of professors. His project intrigued me and so I ended up picking that project and that's the one that I worked on. At that time there were a number of projects, a number of faculty members working on different aspects of oil sands at the University of Toronto, as there were across Canada at that time. There was a huge effort and so I ended up picking that particular project.

AD: And of course that was the AOSTRA funding -- Clem Bowman's vision of having these research centres across the country.

GRAY: That's right, and so there were projects right across the country; it wasn't just in Alberta, it was at different locations wherever there was the capacity and some of the ideas to undertake the work.

AD: So in terms of your initial work at Shell, what did you do specifically?

GRAY: Well, my role was working in the Calgary head office supporting the engineering work at the natural gas processing plants. My major interest was the Waterton plant just outside of Pincher Creek, Alberta, and so I was working with them on looking at long-term development strategies; looking at process improvements; and later on I got involved at looking at potential petrochemical investments, because at that time everything was very bubbly and frothy in the energy industry and so there, at that point, there was a lot of new natural gas discoveries coming on and no market. And so the companies on the natural gas side of the industry were very interested in petrochemicals and other possibilities to try and bring their exploration results to market.

AD: Well, you know, from my work on the -- as science editor of the Canadian Encyclopaedia, I, you know, there were all sorts of areas of interest including coal liquefaction and gasification, I mean ….

GRAY: Yes.

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AD: …all of these. Now, of course, some have been proved, some have been disproved, but it was an area of intense interest in hydrocarbons.

GRAY: Yes, it was, and there was every possible energy source you can imagine being actively pursued because the world had realized that petroleum -- at that time people weren't talking about petroleum running out, but the political issues with petroleum supply were first and foremost in everyone's mind, so the challenge of secure supply was what was driving all of this effort.

AD: So you did your PhD on biomass.

GRAY: Yes.

AD: Why did you choose biomass?

GRAY: It was an interesting problem. I initially started doing a little bit of work on coal conversion, and then at that time the United States government stopped all of its support for work on coal under the -- when Ronald Reagan became president he basically decided that this was a dead end and they stopped it all. By that time, some of the initial shock of the oil crisis was wearing off and the US was about to enter a long period of -- what would I call it -- policy stagnation on energy where they basically hoped it would go away, and to some degree it did for a decade or two. And so at that time I, the project I was working on was cancelled so I picked biomass as an alternate target, one that was a balance between my interests and what was happening in California at the time.

AD: Well, just like your paper at the U of T was visionary, I think that, I mean in terms of biomass, of course, it's becoming more important, so I think you have an uncanny sense of the topic of importance in a particular era.

GRAY: Potentially, although as I've learned, the whole area of biomass hasn't actually progressed very much …

AD: No.

GRAY: …in practical terms since …

AD: No.

GRAY: …since I was there. What's really advanced is newer and better ways of using biomass as a straight fuel.

AD: Yes.

GRAY: Conversion of biomass is still facing all the same problems that I saw back when I was a graduate student.

AD: Over 30 years ago.

GRAY: Over 30 years ago, so most of those issues were well defined then and they're still not overcome despite lots of beavering away. So I guess I would -- I don't want to take too much credit, I like to draw a distinction in picking a general area and picking some of the highlights that are really close to a breakthrough where research would really make a difference, and I don't think my capability is quite as good on that.

AD: So you were hired by whom when you came to U of A?

GRAY: I was hired by Fred Otto. He was Chair of the Department of Chemical Engineering at that time. And the reason was, although Alberta was pretty depressed at the time, this was after the collapse of energy prices, there were lots of layoffs; Calgary was severely depressed by 1982-83. The University of Alberta was starting a co-op program and so that required more professors because of the rotation of courses involved in running a chemical engineering co-op program. And so there was a small group of us that were hired at that time when universities across Canada, on the whole, were not hiring at all.

AD: And so who were the other members of this team that hired at that point?

GRAY: Well, the people who were hired immediately before me were David Lynch, our current Dean of Engineering, and Kumar Nandakumar, who's currently at Louisiana State University. And then subsequently Robert Hayes was hired, so there was a group of three or four of us who were hired within a three or four year period, and then there was a bit of a lull for quite a while before there was hiring again in the mid-1990s.

AD: So tell me about the co-op program and your involvement with it.

GRAY: My major involvement was simply teaching courses. So the co-op program has two components; one is usual engineering and other courses as part of the program at the university with interspersed intervals of going out into industry and working, and then coming back. So my main involvement at that time was just the teaching side, although of course I could see the benefits to the students in terms of what they've gained by going out and working in industry. When we had groups that were coming back, we could see the difference in the classroom. They were much more organized, much more capable in terms of their communication skills. These are some of the things that were really emphasized when they were in industry that are not things that are well classroom-taught. It's very difficult to teach time management, to teach communication skills, speaking, writing, how to summarize information. Those students really picked up a lot of soft skills during their work terms that complemented the more structured learning that we offered at the university. So I wasn't -- regardless of my position -- I was a very early convert to the value of that kind of collaborative education.

AD: And of course this was the era of, you know, the buzz word was technology transfer … from academe to industry so that any of those relationships would …

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GRAY: Yes.

AD: …between a university and industry were valued, weren't they?

GRAY: They were, although in my experience in the oil sands industry, the most important technology transfers -- there have been discoveries and there's been a lot of important scientific work but some of the most significant transfers have been the people that are trained who have the background, who have the analytical skills. They then go out into the industry and start to have a significant impact. If I look at some of the most important developments that have hit the oil sands industry, a lot of it was very bright people who had been educated at the universities and then went to finishing school in industry, picked up the skills in terms of project management and how to do things on a larger scale and then things started to happen.

So the ideas, the industry is great -- or the university -- when you're looking at these huge industries, the university is great for developing ideas, but then there's a whole sequence of events that has to happen before it can be reduced to practice and become an important part of an industry. And often the idea, valuable as it is, it may be many years before it comes to fruition as a fully-developed process concept. If I look at most of the technologies, it really transformed the oil sands industry over the last two decades. In many cases, there were interesting lab observations or ideas that then took an awful lot of hard work to go through piloting and scale up. So technology transfer in the oil sands industry to me takes on a very [different] connotation than if you talk to people in information technologies where if you come up with a brilliant idea for a cell phone app, you can go and commercialize it almost right away. The cycle and the amount of effort and investment and time required for energy production of any kind is much, much longer and much more arduous.

AD: I think that's a significant point because I think that, you know, you have cycles of this and, you know, the government and the University of Alberta … jumped on the information technology bandwagon …

GRAY: Yes.

AD: …you know, everybody wanted to be a Silicon Valley North, etc., but it didn't pan out. In terms of the relationship with industry, and specifically the petroleum industry and …

GRAY: Yes.

AD: …the oil sands …

GRAY: Yeah.

AD: …there has been this incredible relationship between the University of Alberta, and clearly other universities, but …

GRAY: Yes.

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AD: …you were a part of that at the University of Alberta.

GRAY: Yes.

AD: And the co-op programs and then specific research, which is a nice transition for me to ask you then, how did you get involved in oil sands research and to talk about that.

GRAY: Yes. Well, my initial entry was through AOSTRA. So in the late 1970s and early to late 1980s, AOSTRA was very active. They had a long-standing program to sponsor university research that was related to oil sands development and so as a new faculty member I applied to AOSTRA for work on trying to better understand the composition of the bitumen streams, and start to work towards more comprehensive models of how we could understand the upgrading processes. AOSTRA decided to sponsor that work and that was really my entrée into getting to know the industry participants, particularly at that time Syncrude. When we talked about upgrading, Syncrude was really the only game in town. The other companies that were interested in oil sands were much more focused on primary production -- companies like Imperial Oil, at the time was very much into in situ production. That was their major focus.

Syncrude was the company that was interested in extraction, working with Jacob Masliyah, and interested in upgrading working with me and a few others. And so through AOSTRA I got to know the different companies, what their interests were and some of the leading researchers at those companies. In particular, I focused on Syncrude because they had a research centre here in Edmonton, and still do. It's a very active research centre, and here was a group that was speaking the language of research in oil sands here in Edmonton and that was a wonderful opportunity.

AD: So who would've been the company peers at that point that you related to?

GRAY: Well, initially the main contact with Syncrude was through Joe Liu, and he was -- he had an interesting role at Syncrude Research, which has persisted. They've always had somebody who was primarily interested in external partnerships and liaisons. So Joe Liu's role was to link in with the AOSTRA program, to link in with the university labs and the government labs that were doing relevant research, and to try and generate productive relationships as much as possible, and to get the best value out of those partnerships for Syncrude, which is a fair proposition.

The other people were Emerson Sanford, who was a group leader working on upgrading research at that time, and so through AOSTRA and the meetings that were held every year in Banff at that time I got to know some of those people and to start talking more about research relationships.

Eventuall, AOSTRA wound down most of its activities. The university program was handed off briefly and then it disappeared; and, around the same time that AOSTRA disappeared, Syncrude decided that they wanted to put more investment into collaborative research, so they explicitly redirected their effort away from doing as much as possible in-house into a more distributive model. And so the first people they came and started talking to were some of the researchers who'd been very active with AOSTRA. Jacob Masliyah had been active working directly with Syncrude on

developing some of their process models for the extraction process. I'd been working with AOSTRA and a couple of other people had been working with people like Norbert Morgenstern -- had been doing a lot of work in the oil sands industry on a consulting and research basis. So there was a nucleus of people who had the background and the appreciation of the industry based on AOSTRA's investment. Syncrude could come in and start working directly.

So the interesting thing at that time is the province had basically bowed out of active research in this area, basically wound down to little or no effort, and it was the combination of Syncrude plus the Government of Canada through partnership programs of the Natural Sciences and Engineering Research Council that really launched the much-stronger university/industry partnerships that moved forward at the University of Alberta. The AOSTRA partnerships were pretty loose. There was a university program with an industry steering committee. The industry people would dutifully attend the annual conferences and it was a good way to meet and make contacts, but it wasn't really a partnership. There were partnership activities going on the side but what really launched the flourishing ecosystem that we see now at the University of Alberta was Syncrude basically saying, "We want to have longer term partnerships; we want to step away from short-term contracts and move into longer-term research that'll really develop trained graduate students and a focused effort over a sustained period of time." And they were able to leverage their investment with the Government of Canada.

And so through the 1990s that was the model here at the University of Alberta – [it] was industry, federal government through NSERC, developing collaborative projects and really building up significant capability at that time.

AD: And, you know, as I've said to others that it was 20 years of research on the part of Karl Clark and others that resultedin the Blair Report and Premier Manning …

GRAY: Yes.

AD: …opening up the industry for development, or opening up the oil sands for development. But of course we have had significant -- now probably about 40 years of significant university and company research that has resulted in the developments that we've seen …

GRAY: Yes.

AD: …since the mid-nineties, and so good science is essential to the development of any new industry.

GRAY: It is. The other thing that's been essential is sustained commitment and strategic long-term investment, and so AOSTRA was very strategic but then AOSTRA disappeared and, ironically, during one of the key periods in how this whole effort has developed at the University of Alberta, the Government of Alberta bowed out of the picture and it was largely a federal partnership with industry directly that allowed us at the University of Alberta to build up dramatically in terms of our capacity. Moving from short-term consulting-type contracts to five-year commitments for sustained

research was a huge breakthrough for us, and we were able to deliver much more value, I think, to the company partners than we were on a short-term collaborative basis.

AD: And of course you then had endowed chairs as well, which enhanced that.

GRAY: That's been less of a part of the picture, I think. I'm trying to think if we have endowed chairs related to oil sands. There's some that are being built now but that's been a push more in the last few years. So for the 1990s and the first decade of the 2000s, these were mostly five-year commitments on an ongoing operating basis, and endowments have really only come into the picture with the establishment of the Centre for Oil Sands Innovation and a couple of other endowed chairs that the Faculty of Engineering is trying to build.

AD: And I'll ask you specifically about that …

GRAY: Yes.

AD: …but I'm going to pull back in terms of the chronology and how did you define your research interests in oil sands, you know, thinking back to the eighties when you …

GRAY: Back to the eighties?

AD: Yeah.

GRAY: Well, at the time Otto Strausz was very actively working on understanding the chemistry of the oil sands, but Otto is not a chemical engineer and so the gap that I immediately observed is Otto was -- Otto Strausz and his team were generating huge amounts of chemical information but they were struggling to relate it to how the industry actually operated. And so the work that I was doing was trying to come up with tools and relationships; how could we take a chemical reactor running at Syncrude, for example, and use some of the insight on the chemistry to do a better job? How could we raise our understanding of this very complicated bitumen material to do a better job of processing the bitumen into value-added fuels? And so that was the -- that's basically the area where I've been working ever since, broadly defined. What are the -- what's the composition? What are the properties of this material? How does that dictate how large-scale industrial equipment operates? What can we do in the lab to better understand how to push that technology forward?

AD: So, I mean, from your perspective, you know, the research that Clark did was really, you know, using a sledgehammer to crack a nut. I mean that the separation did occur using diluents and other things, but there had to be a more sophisticated and refined approach. So do you want to talk about your research and….

GRAY: Okay.

AD: …specifically your breakthroughs and innovations?

GRAY: Well, I guess what I value the most from my time is coming up with a much better understanding of the composition of bitumen from an engineering perspective, not a detailed physical chemical series of measurements, but how do we understand this material at the level of detail that we can then use it to analyse a large-scale process? And most of what I've been working on is what we call upgrading, which is taking the bitumen after the hot-water process, after it's been cleaned up, and then try to do something useful with it because nobody really wants the bitumen. It's -- well, I shouldn't say that, we're selling more and more diluted bitumen but it's really not a desirable end-product. It needs dramatic processing in order to make valuable transportation fuels.

And so what I think I've done -- the biggest contribution is on trying to understand how, what we know about chemistry applies or does not apply well to this complicated mixture. What happens when you start processing this kind of feed stock at temperatures over 400 degrees centigrade at high pressure? What are the catalysts really doing and what are the components within the bitumen that really control that whole process?

Ironically, I think it's really only been in the last two or three years that I'm satisfied personally that I've answered those questions thoroughly, and that we've really set the scientific basis for process technologies for this material. Empirically, people were building and operating these things for many, many years but now we finally nailed the details of the chemical science to the point where we can really integrate what's the basic chemistry with how do these reactors operate. In the past, when I first got involved in oil sands, there was no agreement on what the important components where, what the real reaction pathways were; if you put a catalyst in, what was it really doing? And so half the time you were operating in the dark. You were making guesses. Sometimes people were making inspired guesses; sometimes they were totally and utterly wrong about what was happening, but they had -- they had empirical information and they were doing their best to link what they were putting [in] with what they were getting out.

What I think I've been able to contribute the most is making the link between those two. If this is what you've got, this is what you can hope for; this is about the best you can do; and what are the pathways in between -- how can you try and make it better?

AD: So what would be some of the improvements, thinking at the plant level of this kind of understanding?

GRAY: Well, one example is we realized that bitumen is a liquid material and the history of chemical-reaction engineering, my core discipline, is they don't really like liquids very much. Liquids are awkward. A lot of the work was done on ice gas streams. Gas is much better behaved, so it's low density; the reaction pathways are much, much simpler in the gas phase, and so a lot of people's understanding was all based on the fundamentals of gas-phase chemical reactors. Syncrude, Suncor, they don't operate gas-phase conversion units for bitumen; you cannot put that material into the gas phase, it's always liquid. And so understanding how materials like coke develop; how the different components react and change, I think that's where I've made the most contribution. That's been the most exciting thing for me.

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So for Syncrude, we did some very significant work on understanding how the large molecules broke apart and what those fragments were doing in the liquid phase versus if we could get them into the vapour phase. And so we came up with some innovative lab-scale reactors that said how can we get those cracked fragments into the vapour phase as fast as possible? What does that do to the yield and what does it do to the quality of the products? What we found is, if you can get the molecules to crack and into the vapour phase as fast as possible, you get much less coke by-product; you get more liquid product and you get better quality.

So that got Syncrude and other companies thinking along a whole different direction. What could they do with process technologies in order to do better? So Syncrude is still working on process improvements. How can they put the liquid feed into their reactor to get those crap products out as fast as possible? Other companies, there's a small company called Envision Technologies that was developed by a couple of former Syncrude employees, they took some of our ideas with some completely novel ideas of their own and have developed a new reactor technology to try and get more product out of this raw material using some of these ideas based on these lab experiments.

So sometimes if you get a good scientific or applied engineering observation, other people will come up with interesting ways of using it that the discoverer would never have foreseen, and that's certainly been my experience in this case.

AD: Now, you know, from other interviews [research] that moves from lab bench-scale to then a model and then moving up to full production.

GRAY: Yes.

AD: Can you talk about your involvement in some of those activities testing....

GRAY: Yes.

AD: …you know, these theories and …

GRAY: Well, my involvement has been more peripheral on some of that. For example, working with Envision Technologies; they went out and built a pilot plant out at Devon at the Canmet facilities there in order to test their ideas of how they could combine an innovative reactor concept with some of the results of the work that we had done here at the University of Alberta. My involvement at that point was more as an advisor to give them feedback on their process design to try and point out issues they should be worried about based on our experience in the lab, and so there was a good collaboration in that, but it was, I wasn't driving that process. But it was fascinating to see the series of steps and some of the struggles they had to go through scale-up to get up to a scale of about one-barrel-a-day of feed stock.

Things that we don't even think about in a lab become crucial when you go to a larger scale of operation, and it impressed on me, as I mentioned to you earlier, the long and arduous path from an

interesting idea in the lab to a technology that is ready for application in industry. There's an awful lot of effort and time, and money, that have to go into that transition.

AD: Now, you know, you mentioned that when you did that research paper at the U of T, you were actually working with bitumen that had been shipped out there. But when I interviewed Jacob Masliyah, of course, you know, we've moved into -- he'd never seen this stuff and that it …

GRAY: Yes.

AD: …so that it's really computer modelling; it's talking about other things and, of course, I'll talk to you about the whole nanoscale and …

GRAY: Yes, yes.

AD: …development at the U of A. So that it's theoretical -- that you're not actually in a lab with test tubes full of the stuff doing that physical chemistry kind of thing. Do you want to talk about that?

GRAY: Well, I'm primarily an experimentalist so my background is mostly doing experimental work. Some of my first formal experiments ever were on oil sand material trying to burn away the bitumen so that we could analyse what was happening in the sand and clay material that's left over. So I'm a big fan of getting into the lab and trying things with the actual materials …

AD: Okay.

GRAY: … and getting that experience and getting a physical feel for how it behaves so that you're not getting off on theoretical flights of fancy that may or may not work for good solid reasons that you've overlooked. So that was my background -- here's the material, here's the bitumen material, now what are we going to do with it? What do the products look like? What does the stuff smell like? All of those physical interactions with that material. So I -- my own activities have been much less on the theoretical side, much less on the computer modelling side.

AD: But with the kind of equipment that, you know, Karl Clark and others couldn't have dreamed about …

GRAY: True, true. And we, what Karl Clark wasn't able to do at the time because a lot of the techniques hadn't been developed, he was not able to relate some of the observations that he was coming up with -- was what, well, semi-pilot scale. A lot of the work that he was doing at the university was kilogram quantities of material. He wasn't working with little 10-gram aliquots; he was working with kilos, kilos and kilos of material. So his was semi-pilot and trying to go to more continuous processing. So he was always very hands-on right from day one. He was trying things at a lab and that was partly because he didn't have the -- background at the time didn't exist to say, "Well, what would be the ideal well-controlled scientific measurement that would give insight into this behaviour."

I think we're more able now to say, "Here's a practical problem, now what would be the simplest and cleanest experiment we could do in the lab to shed light on that?" And you could call that a scale-up or scale-down question. Take a big industrial problem; how do you scale that down to a measurement you can do and control well in the lab and give useful insight? That's where I think we made the biggest advances in terms of instrumentation and theory -- to say, "Okay, what are those defining measurements?" If I look at what I've done, what Jacob Masliyah has done, often we're doing measurements experimentally in very, very simplified, well-controlled systems, but you can immediately take those conclusions and make inferences about what the industry should be doing.

AD: You began some remarks earlier by focusing on transportation fuels.

GRAY: Yes. Yes.

AD: Has that been the focus of your research?

GRAY: Indirectly. The area of upgrading is to take bitumen and turn it into a synthetic crude oil with properties that are closer to crude oil and are ready to go into a range of refineries. Now, that distinction between upgrading and refining is a little bit blurry but, in general, how do you process the really big molecules and bitumen, whether you do it at an upgrader or at a refinery anywhere in the world, into diesel fuel, gasoline, jet fuel? Those are the ultimate goals but the key challenge is taking really big nasty molecules, breaking them down with the highest yield possible to get the fragments that are most valuable for clean fuels.

AD: Now, there's a range of materials that are left over when you do this, and have you dealt with that? I mean the stuff that goes into the tailings ponds and -- I mean, now with in situ it's …

GRAY: Yes.

AD: …it's different, but have you looked at the chemistry of these undesirable by-products?

GRAY: Well, in the upgrading world the main by-product of concern is what we call coke. This is a solid by-product from bitumen when you heat it up and crack the molecules just by applying heat. The objective, in terms of making a more valuable processor, [is] to minimize the yield of coke as much as you can. And so what I described to you earlier about understanding what happened in the liquid phase versus vapour phase, understanding how these molecules actually behave is crucial to understanding how can you manipulate the bitumen to get as little coke as possible? Now, before I ever learned about any of this, some of the major approaches had been developed empirically and some of that work went back to the 1930s, which was when a lot of the early refining technology development was done.

In the United States and Germany they came up with the two major approaches. You either take these large molecules and heat them up, or you take these large molecules, don't heat them up quite as much, but add hydrogen in a catalyst -- hydrogen gas. Those were the two main pathways and

today those are the two main pathways. That continues to be the bulk of what the industry is doing; or that's actually all that the industry is doing and they haven't broken out of that mold.

And so the challenge has always been --how far can you, given the molecular structure, how far can you push either of those technologies to get either as little coke as possible or as much liquid product in the hydrogenation pathway with as little cost as possible? So it's, in a sense you could argue it's all just been optimization of an idea that was already there from 80 years ago. But that's, that's often the way these studies go.

AD: Now, when did you become Department Chair?

GRAY: Oh, that's a good question. I'm trying to remember the year. It was probably around 1993 or '94. It's in my resume but I don't remember the date.

AD: So clearly you then, I mean …

GRAY: Or maybe it was a little earlier; might've been around 1990 [July 1990 to December 1993]. Anyway, it was …

AD: Oh …

GRAY: … in the nineties.

AD: It'll be in the resume. But when you're an individual researcher and professor, you have a certain sphere of influence, but when you become the Department Chair …

GRAY: Yes.

AD: …that's a whole different ball game, and so I want you to talk about that and in terms of the Chemical Engineering department, how much of it related to the oil sands and oil sands activity?

GRAY: Well, at the time when I became Department Chair, there were really only two people working on oil sands on a sustained basis. Unless my memory is completely wrong, it was Jacob Masliyah and myself, at that time. Jacob had been doing a lot of work with Syncrude, particularly on modelling, and I had been doing work with -- at that time mostly with AOSTRA. I was just starting to get work directly going with Syncrude at that point. And so I don't think at that time -- it wasn't, it wasn't in my mind at that point that oil sands would be what it is today.

AD: Okay.

GRAY: So at that point I knew very clearly that oil sands was a strategic long-term interest for Alberta, was a huge resource, but at that time the industry was in the doldrums; energy was not at the top of everyone's mind. That was during a period where nobody was paying much attention and

so it was not at the top of anyone's agenda. And, in fact, in my own work I'd started some work doing biotechnology at that point because …

AD: Okay.

GRAY: …I couldn't get students in oil sands, they weren't interested; the students didn't see a prospective future, and so I was doing work on oil sands and also work in other areas that were more attractive to graduate students. It wasn't the funding that was the issue; it was the graduate students that were the issue. So as Department Chair, my focus was not what can we build on oil sands, but rather who in the department is really doing interesting and innovative work? And, in particular, who is working well with industry and how can we try and build those partnerships? So by the time I finished being Department Chair, I was involved in some discussions with Syncrude, trying to get them to partner more with Jacob and that work was continued by Sieg Wanke, who was the Chair after me, and Sieg was the one who put the ink on the -- who inked the final deal with Syncrude that set up Jacob's initial chair, which really set the model for so much that has happened at the University of Alberta since then.

So that was a process that I began as Chair because I saw the opportunity and I also saw that Jacob was taking a leadership role. He had been working in fluid mechanics for many years; he'd done modelling with Syncrude. He took a year out of sabbatical to basically retrain himself to better deal with all of these problems of what happens to fine particles and oil sands as you're trying to separate the bitumen from the sand, and he spent a year reading and writing and basically retraining himself in a completely different area of science from anything that he had done before. So he was clearly visionary in terms of his own career of saying, "This is something I want to do; this is an area that I want to focus on," because the kind of work that he'd been doing, which was applied to oil sands and many other things, he could see it was disappearing. It was -- he'd done what he could do and he needed new tools in order to take on new challenges.

So as Department Chair, my job was to support him and others who were trying to build up research careers, build up their research ideas and to get more recognition.

AD: So then, if I remember correctly, you continued in administration and you became …

GRAY: Yes.

AD: …the Dean of Graduate Studies.

GRAY: That's right.

AD: And, you know, why did your career go in that direction?

GRAY: At that time, I was interested in trying something completely outside of engineering and so it was a new challenge -- nothing to do with oil sands, nothing to do with engineering -- this was trying to lead the university's graduate programs on a university-wide basis. So for me that was a

personal and professional challenge. It wasn't a research activity at all. But it was unique in that it was a leadership role I could play at the university and still stay active in research. So it wasn't so all-encompassing. In those days, being a Dean was not a 100 percent administration and leadership; there was time to do research and so I was able to continue working on my research career and not abandon it by taking on this challenge in a leadership role at the university.

By the time my term as Dean was finished, it was clear that I couldn't do that anymore; it was either commit to the research or commit to being a Dean or whatever. I couldn't do both and so at that point I decided to go back to being a professor because I wasn't prepared to say, "Well, I'm now going to let the research go downhill." I couldn't, I couldn't sustain it at a level that I wanted it to be at. I had to make a choice.

AD: And so then you went back into, you know, being a researcher and professor and …

GRAY: Yes, yes.

AD: …having graduate students. When?

GRAY: Oh, what year was that? It probably -- I can't get the exact dates -- it was probably around 1998.

AD: So I mean in terms of the timing for the industry -- we had had the federal/provincial agreements, the new royalty regime, I mean …

GRAY: Yes.

AD: …you know, that allowed the industry to recapitalize and …

GRAY: Yes.

AD: …the new players, new developments …

GRAY: So that, that was just starting at the time.

AD: Yeah. So your timing was good.

GRAY: The timing was good, and so at that time I went into a partnership with Syncrude and started a research chair focused on upgrading. So Jacob had laid the path by doing a chair on extraction. I came in with Syncrude as partner and started on upgrading. And so I don't remember the sense at the time that the industry was about to take off, but clearly the foundation was there for dramatic expansion with Suncor and Shell coming into the oil sands in a big way; Suncor committing and expanding; Shell coming in for the first time. And that really opened up the industry internationally, dramatically increased the scale and activity of the industry, and also started on some

good and bad things that developed at that time. From what had been a very small sort of "cottage" experiment in Northern Alberta to something that started to get worldwide recognition.

AD: So the second era of your research, what did you focus on?

GRAY: I continued to focus on upgrading -- the kinds of problems that I've discussed. We tried a few other things that turned out to be blind alleys. We tried to apply biotechnology to the oil sands.

AD: Tell me more, I mean, because, you know, this is a "raw" bit of history that's going …

GRAY: Oh, yes.

AD: …into an archive, so …

GRAY: Yes.

AD: …successes as well as failures are important …

GRAY: Well, I'd had …

AD: …what you learned.

GRAY: …I'd been doing quite a bit of work on -- on bioremediation. I was combining my interest in oil and bitumen with work in biotechnology, working with a very good collaboration with colleagues in biological sciences, with Julia Foght and Phil Fedorak and Mike Pickard, all of who were microbiologists doing a lot of work on petroleum compounds. We'd had an active collaboration on trying to clean up oil spills and other soil contamination problems starting in the early 1990s and so I decided I would try and apply some of those ideas to processing of bitumen fractions. So we were trying to use bacteria to process components of bitumen. We also did a little bit of work at that time trying to process not only some of the lighter, easier molecules, but some of the really heavy stuff. And so that was interesting and informative. Between my work on bioremediation and my work on trying to do bioprocessing, I appreciated the severe problems of trying to do biological processing on these kinds of materials. I still think there's some opportunities but biotechnology is not a natural fit to doing anything useful on bitumen because of its physical properties and its biological history.

AD: Well, you know, it sounds like a utopian ideal that you use something natural, I mean that's …

GRAY: Yes.

AD: … what biotechnology is about and, you know, the solution that then, you know, you wouldn't have to, you would not have detrimental impact on the environment; all of that …

GRAY: Yes.

AD: …so.

GRAY: Well, from a scientific point of view we were more motivated by trying to see if we could promote reactions that we couldn't do any other way.

AD: Okay.

GRAY: So we were looking at two types of reaction chemistry; one was trying to open up ring compounds. There's a lot of cyclic in ring compounds. In the products of bitumen, this is relatively undesirable for transportation fuels, particularly diesel fuel, and so we were trying to open those up. I was also interested in seeing if there were other ways of removing some of the contaminant atoms, particularly nitrogen. I knew what the existing technology could do -- the thought was "Could we use biological catalysts as a completely different way of dealing with this material." So under the chair program I was doing with Syncrude, all of the focus there was on relatively low-molecular-weight components where we knew if we had the right biological catalyst, there was a chance of getting the reactions to proceed. Whether it was economic was a completely separate question, but at least we knew that we could get biological reactions to occur for these kinds of molecules. And we did get biological transformations to occur; we just weren't able to get them to occur well enough with the right products to make it attractive for further investigation. So that some aspects of the way the bacteria were doing the chemistry initially we thought were promising; in the end it turned out to be a dead end.

But through that process I learned a lot about what are the limitations of how bacteria deal with molecules from petroleum, and the simple explanation is the bacteria are extremely efficient dealing with molecules below a certain size, and they will chew them up and rapidly get energy from that material, and there's still potential, I think, to try and use some of those biological pathways -- potentially for processing, although you do have to be very careful because the bacteria's interests are not necessarily the refinery's interest in terms of what they're trying to achieve; but there's interesting potential catalysts in that space. But, when the molecules get over a certain size, basically the bacteria give up and there's basically no way of getting useful processing. It is simply not going to happen ever, no matter what you do to the bacteria.

And so I learned something about that limitation in terms of what biology could do. So the conception that keeps coming back in literature and in conferences of "Let's sprinkle some pixie dust into a well, in the oil sands, and we'll get light, clean oil flowing out …."

AD: That's your…

GRAY: … after, after doing some incubation. That is …

AD: Without any damage to the environment.

GRAY: Without any damage to the environment and without putting any other investment in, that is simply not going to happen based on the rules of biology, chemistry and physics.

AD: Okay.

GRAY: It's a non-starter, and so that's what I learned from a lot of those studies -- is learning more about what are the barriers that you cannot cross no matter how clever you are because of the way the molecules are and the way biological systems are. As long as you have those characteristics, you can't cross the divide.

AD: Now, in your own career you've experienced the companies doing proprietary research; you've experienced the collaboration with academe that was really spurred by AOSTRA, and then of course continued through industry and NSERC …

GRAY: Yes.

AD: …funded research, but also the whole collaborative model where industry -- a number of players in the oil sands -- are collaborating together.

GRAY: Yes. Yes.

AD: And so we're moving -- there's the Syncrude era of your research, and you may still be in a Syncrude era, but also Imperial Oil then becomes important and I'd like you …

GRAY: Yes.

AD: …to talk about that. But also, you know, the new ways of looking at research that is more collaborative.

GRAY: Yes. Well, the interesting thing with the collaboration with Imperial Oil, it was -- that whole effort grew out of some conversations between the then President of Imperial Oil in Canada, the President of the University of Alberta Rod Fraser, and David Lynch, Dean of Engineering, and at that time Exxon Mobil, the parent company, was investing in some major initiatives at Stanford University in a collaborative mode with other companies, and they said, "Well, you can go and talk to them," and the University of Alberta was pushing back and saying "No, no, no, you should come and work with us on oil sands because we are the place where things are happening. We shouldn't be a little flea on the program at Stanford, that doesn't make any sense, and that doesn't do justice to the potential of the oil sands."

And so through discussions, the idea for the Centre for Oil Sands Innovation came about where there would be an endowment established, funded by Imperial Oil, and the university would then go and get operating funds, as well as using the income from the endowment to have long-term, sustained effort on oil sands research. The most important part of that from my perspective is not just the model of how it happened, but the explicit recognition by Imperial Oil at that point that they were not happy with the available technology. So they were very upfront. They did not see that they could still use the same technology 20, 30, 40, 50 years out.

AD: Okay.

GRAY: The resource was there; the oil was there; they had the leases; they had the mine plans, but they -- their position was they couldn't continue to use the technology as they had at that time. They needed new approaches and so they, they wanted COSI [Canadian Oil Sands Innovation] to be a sort of "skunk" works to try, even if they were off-the-wall, if they made sense potentially, if you could get the idea to work, if it made sense in terms of a new opportunity for the industry, they were willing to try almost anything as long as there was a path of how that idea could possibly be translated into practice.

AD: Now, Imperial Oil, of course, had had its own research establishments. It was involved in the UTF [Underground Test Facility], the in situ work, so why did they become interested in this?

GRAY: Well, I think they saw …

AD: Or did it for them.

GRAY: They saw some big differences. Well, two things -- they saw some big differences between oil sands and in the mining side and their work on in situ. So part of the scope of COSI was to focus it only on mining extraction and upgrading of the minable oil sands. They thought, and they still think, they knew what were the opportunities; what were the potentials of all the in situ technologies. They were continuing to develop them and are developed [focused] at developing their own technology today. So they didn't feel they needed university help in that. Where they needed help was come -- was this problem of how do you come up with completely new technologies; how do you try ideas; and so they saw having a university partnership as a way of dramatically amplifying what they could do themselves. Doesn't mean they gave up on that question themselves; they've continued to look at alternative technologies, completely different ways of doing things. But they see the university collaboration as an important adjunct to that. And part of it is also that COSIA is not just University of Alberta; it's led by the University of Alberta but we engage other universities as well where there's capability, and where there's particular ideas available that we can try and build on.

AD: Do you want to talk about some of those ideas and other universities that you've involved other industry players?

GRAY: Well, as an example, let me give you an idea of what the status of COSI is today. We're working on three major programs, three major themes. The one that's been longest standing that we identified right away was what you might call "water-free" extraction. How can we get the bitumen out without using warm water, without generating tailings ponds to get around rather than trying to fix the tailings problem: how can we get out of it all together; which is a good engineering approach -- don't just look at the end of the pipe; go back to the beginning and say "Well, what could you do differently?"

So we've been working on a variety of projects to understand how solvents and bitumen and oil sands components interact; how can we get the bitumen out and recover solvents in a process that has potential to be most efficient and environmentally responsible.

And that's looking extremely promising and that's our -- one of our biggest and most important areas, and where Imperial Oil has been working along in parallel working towards being ready for a pilot type of demonstration plant to actually take it to a commercial scale. So that one is looking promising, although they've been a little coy at saying -- until they make the decision they won't say when they will make the decision to go ahead with a major investment. But we're getting close to the point where the next stage would be a 50-million-dollar pilot.

AD: Okay.

GRAY: Which is -- gives you an idea of the amount of investment required. So that was an area that we'd identified right away. Initially we wanted to stay away; we had a premise that if the only result from a research project would be an incremental advancement on what we had already, that we weren't going to do it. We wanted new scientific insights or process ideas that were completely radical, that if they worked would have a dramatic impact on the industry. So hence we decided we were not going to do any work on warm-water extraction; we were going to focus on using chemical extraction instead and focus in that area.

Second theme that we developed right from the start was upgrading. What can we do to the bitumen that would bypass the known limitations of the two main pathways that are available? Heat it up or heat it up with hydrogen. We know what those do. Those two pathways COSI doesn't touch. We look instead at what are alternate ways of trying to get more effective and -- both environmentally-effective and cost-effective upgrading technologies.

The final area that we've been developing most recently in contradiction to what I just said is tailings. Because of the importance of the tailings to the mining industry, we're now doing some work on tailings working in partnership with multiple companies; so non-aqueous extraction and upgrading are both in partnership with Imperial Oil. The work that we're doing now on aqueous tailings is with the whole industry. We're partnering with COSIA, which is why we probably have to change the name of COSI -- it's the Canada's Oil Sands Innovation Alliance -- all of the industry partners have got together and said they're going to share all their technology on oil sands tailings and so we're working with that group of companies to try and see if we can come up with a better way of dealing with tailings. That's a big challenge but it's such an important topic to the industry that we're trying to help out.

My personal opinion, it's probably the longest shot of the three in terms of making a commitment, or I should say making a significant contribution. So in the non-aqueous case I think we're making great progress and I think the indications are that Imperial Oil should commit to a pilot because it looks very promising. In the area of upgrading, we haven't been quite as successful. We've been trying a whole series of areas, some of which have been dead ends, like the -- well, COSI didn't

sponsor the biotechnology work, but that kind of an idea where you say "Let's take a graduate student, try something out, see if it works; if it doesn't work, then, we'll go on to something else." So we've had a fair bit of that, looking at possible upgrading pathways.

The most promising area right now is some radically-novel catalysts that are being developed in the chemistry department here at the University of Alberta that are -- that have the potential to completely change how an upgrader operates in terms of the temperatures and pressures required to make use of hydrogen. So it is at hydrogen, that pathway, but it would be at low-pressure, low-temperature if these catalysts prove up the way their initial indications are showing. This would be a radically-different way of trying to process bitumen.

In terms of other industry partners, we've got a partner working in Germany coming up -- that's the project that's just wrapping up; they've been making molecules that represent some of the big molecules that we think are in bitumen and understanding better how they behave. We've had some very good work with Christian Detellier at the University of Ottawa who's a leading expert on clay materials because the clays are so important in oil sands, and so he's been doing a lot of work on how clays and bitumen interact, and what can we do to change that interaction to do better recovery processing? We've been working with University of British Columbia doing some very fundamental work on understanding what happens at mineral interfaces. We know we have sand and clay interfaces; what do the bitumen molecules really do on those interfaces? And so the lab of Keng Chou at University of British Columbia has the ability to actually look at those surfaces in ways that I'd never conceived of before we got him to start thinking about this problem. So these are examples of some of the expertise that we brought in on these projects.

AD: But thinking outside the box.

GRAY: As much as possible. We run two or three workshops a year where we try and get people that know nothing about oil sands to come in and think about what could be done that would be different. How do you -- how do you spark innovation when you know a lot about the material you're starting with; you know what the industry is doing now. How do you come up with completely new approaches? It hasn't been easy. We've, as I say, we've tried a whole series of things but we're always trying to get new people into the room to bring their ideas and hopefully come up with something completely different.

AD: So, you know, individual professors and their graduate students and these research teams are crucial, aren't they?

GRAY: They are indeed.

AD: And so can you talk about -- I mean in terms of the comparison, I'm thinking of the medical faculty and the Diabetes Protocol and things like this, you know, where the university has done this and put a huge amount of effort and also intellectual know-how …

GRAY: Yes.

AD: …to arrive at some of these breakthroughs. Now do you want to talk about some of the teams and players….

GRAY: Yes.

AD: …at the U of A in this area?

GRAY: Well, I guess the -- what can I say about that? A lot of what we've been trying to do through COSI -- my most recent effort has been to try and set up teams and keep them talking to each other, and this is one of the biggest problems that we have at the university. It's easy to often get a graduate, get a professor, starting on an area. They'll get graduate students involved, but they don't necessarily keep in touch with their colleagues down the hall working on related projects. So one of the challenges with a centre like COSI is to have regular points of contact so that we push the researchers to talk to each other, we make sure that they're aware of what the lab down the hall is doing, so they're trying to work cooperatively as much as possible, and that we try and avoid having them develop into silos where they're working on an area and not communicating back and forth.

And that continues to be a problem, although we have a huge amount of oil sands research. To some extent, the individual professors reach out and make linkages outside of their own particular group, but to some extent the industry partners serve that function because they don't tolerate silos very well. And so a company like Syncrude, they're involved in multiple projects; they serve a crucial role of helping to make sure that there isn't duplication and that the work is complementary; and in some ways they're better positioned to do that than the academic researchers; there's limitations on what we can do in terms of sharing information back and forth within the university; time limitations as well as the way academia works.

So if I look at the collaborative projects that I've been involved with, a key role of the partners is to keep an eye on what's happening to make sure the work is novel and relevant, and not duplicating something else; and they're extremely good at that. Within COSI, we rely very heavily on Imperial Oil, both to keep us on track in terms of not to say what the research should be, but don't duplicate work over here …

AD: Yes.

GRAY: …don't go down this blind alley unless you have something that really would change the picture. It's been remarkably positive -- when we first got involved in the partnership with Imperial Oil and Exxon Mobil in the background, we thought "Well, Exxon Mobil, the biggest oil company in the world; we would hear a lot of 'don't do that, we've done it already.'" And that's not what we got at all. When we thought we had interesting ideas, they were coming back with very reasoned suggestions, very helpful, which was an affirmation that we had an idea based on basic science that was novel, and also that they were helping to nudge it along to make sure that it didn't duplicate work that had already been done, that was already well-known and that we didn't miss connections that were out there that we should be making.

So that's been, in terms of the core science, there's more involved in these collaborations with industry than you might think. It's not just "How can we use the results" from the industry in our industrial operation, it's also "Who else is working in these areas? What's happening in terms of proprietary technology, not just refereed literature that the academics know so well." So it's an interesting counterpoint and complementary mindset.

AD: Now, you talked about the size of these research efforts. Would you have a ballpark in terms of an annual investment on the part of the industry in oil sands-based research at the university?

GRAY: I don't have a good idea of what that would be. Can I give you an estimate?

AD: Yeah, go for it.

GRAY: No idea. What would the order of magnitude be at the University of Alberta? I would guess it's probably in the range of 40 or 50 million dollars a year.

AD: Which is significant!

GRAY: Which is significant, and then you start to match that with other sources from the Government of Canada, from the Province of Alberta and you do get a very large research effort as a result.

AD: Well, you see, talking to some of the people who came to the U of A in the engineering faculty in the late sixties, the seventies, that … the university did not have this capacity. They had to build it.

GRAY: Yes.

AD: And that the PhD's came from Stanford; I mean --and I'm thinking petroleum engineering of course -- but that now, you're training all sorts of people who not only work in the industry but in research establishments, whether it's universities or …

GRAY: Yes, yes.

AD: … or elsewhere, so that is incredible, not just the innovation side, and I think you began with that … in terms of talking about the co-op programs, that you do have an international reputation in this area and that you are on a par -- and maybe you could follow that through with other research establishments at other universities. Maybe do that comparison for me, I mean in terms of how you rank.

GRAY: In, in which sense beause the …

AD: In terms of oil sands based research.

GRAY: Oh, well, in terms of oil sands there isn't a lot of competition.

AD: Okay. So…

GRAY: It's a uniquely …

AD:…I mean, you're the game.

GRAY: Well, in a sense that the oil sands industry as we know it is primarily a Canadian effort, both in situ and mining, Canada has been the major, the major area where there's been sustained investment. At one time, Venezuela was doing more but they've disappeared from the landscape, completely wiped out in terms of R & D.

AD: Yeah.

GRAY: So 25 years ago Venezuela was a significant player, now it's pretty well Canada as the world leader in mining and in-situ-based technology and R & D development. So if I look at the University of Alberta, particularly on the mining side, there's really nowhere else that's substantive -- and that covers everything from geology to mining to extraction to upgrading to land reclamation to dealing with tailings dykes -- every, every aspect. There are experts and groups of graduate students working at the University of Alberta so there's really no comparison; it's orders of magnitude ahead of any other institution in the country of any type, whether it's government or academic on the mining side of the industry.

Now if you look at the in-situ side, the other major centre is University of Calgary where they've got a significant effort in that area, and a significant history of contributions on that side of the industry. They're not quite as dominant there as they might like to think, but they're clearly the Canadian leaders and probably, I would say, international leaders in terms of in situ-oil sands work. I don't think that the Stanfords are anywhere close to what they're doing at Calgary.

AD: You know, which is intriguing, isn't it? Because, when I interviewed someone that is involved on the supply side of the oil sands -- it's forestry products -- and you can look at the Stantecs, the engineering, all of those components because, when you look at the implications -- for the industry in terms of all aspects, it isn't just the products themselves or the job creation, you know, up in Fort McMurray, or wherever, but you have to look at academe; you have to look at the research establishments. All of this is enormous value-added and … as a science editor in the eighties of the *Canadian Encyclopaedia*, … they began to look at biotechnology; they began to look at information technology; and … at economic diversification; but … in terms of the oil sands industry, you've got huge economic diversification -- when you look at the knowledge and the skill sets that are required by the industry.

GRAY: Well, I would say you have huge -- a huge ecosystem of any number of specialty technology, supply requirements, expertise. I'm not sure if it's diversification in the sense that the Government of Alberta uses it …

AD: Yes.

GRAY: …which is not being welded to a single economic cycle…

AD: Yeah.

GRAY: …on a single product. So the oil sands is extremely important in the Edmonton region in ways that people don't appreciate because it permeates so many different businesses in terms of supply and fabrication and logistics and transport; you name it. I don't know if -- I'm sure Edmonton Economic Development has tried to do an estimate, but I don't have it at my fingertips of what the economic impact is as a fraction of the GDP of the city. If you look at oil sands in that way, it will be a large fraction.

AD: Now, in terms of your career, you focused on upgrading, which, and of course the whole debate that -- do you continue to build upgraders in Alberta? I mean, forget just Fort McMurray, which has a huge infrastructure crunch, but of course now we're talking about the transport of diluted bitumen …

GRAY: Yes.

AD: …for processing elsewhere. Now, what do you think about that?

GRAY: Well, as somebody who would like to see more development in Alberta and more …

AD: Mmhm, well that's why I'm asking.

GRAY: …value-added. I think it's unfortunate and it's unfortunate in ways that I don't think people ever foresaw, and let me explain that. There's the obvious economic impact. If you -- if you always ship the lowest-value-possible product, you're foregoing potential benefits of value-added processing. Upgrading is manufacturing.

AD: Yes.

GRAY: Refining is manufacturing, so if you're always shipping the cheapest-possible raw material, you're getting no economic benefit from any of the subsequent manufacturing steps. On the other hand, the challenge to that is you have to make money. You can't just do it by government fiat because otherwise you get into all sorts of distortions, and a government decision isn't enough to make it an activity that actually makes anybody any money. So you have to be cautious because we've seen this in upgrading of sometimes politically-driven decisions that don't make economic sense, or that have risk cycles that people don't fully understand.

The other cost, though, is that the oil sands industry has now been demonized because of shipping diluted bitumen. In the United States, they think that bitumen is an awful material that is much, much worse than anything in petroleum; it's radically different. Of course, it's all nonsense. There

is no -- bitumen is a petroleum material and diluted bitumen has most of the same toxicological and health properties of any crude oil material, but it's been demonized as being unique and Canadian and bad, and environmentally damaging in every possible way.

I'm not sure that that would happen if the proposition was "Let's ship light, sweet, upgraded crude oil in a pipeline and there will be no diluted bitumen; it will be upgraded in Alberta and shipped as a light, sweet product"; I'm not sure if the political debate in the United States, in Vancouver and Victoria or in eastern Canada on the various pipeline proposals would be the same if the production was to come out as light, clean product versus …

AD: Supposedly dirty …

GRAY: …the dirtiest possible petroleum product you can produce.

AD: Yeah. Yeah.

GRAY: I'm not sure that that would really change the debate. I suspect the debate would just shift a little bit because fundamentally many of the groups that oppose the pipelines are opposed to fossil fuel development period …

AD: Yeah, period.

GRAY: … full stop. Doesn't matter how clean it is -- it's fossil fuels.

AD: Yes.

GRAY: So some …

AD: Or how unrealistic in terms of like lifestyle that we currently enjoy and that they …

GRAY: Right.

AD: …currently enjoy.

GRAY: And that's part of the whole debate about what the environmental movement is trying to do; what's constructive; what's destructive in what they're actually doing. But when I look at the pipeline debates, sometimes it's framed as "diluted bitumen," "dirty bitumen," "dirty oil sands," and it's a black material and, to some extent, in terms of the properties, it is the worst-possible petroleum mixture that you could ship by pipeline. And so the lack of upgrading starts to play into the hands of the demonizers, in addition to being -- so you got a double loss -- the loss of not being able to ship it is just as bad as the loss -- or is even worse -- of not being able to get the value-added on manufacturing. So potentially with oil sands, we're looking at a lose/lose scenario where you're not only not getting the value-added of the manufacturing, but it's getting land-locked, locked in Alberta

where you don't have the capacity to ship it to markets; even though there are willing markets out there, the logistics of getting it there is not so simple.

AD: Now if you look back at the early Lougheed era where, you know, a certain number of upgraders were supposed to be built. I mean … huge numbers. Do you think Alberta has the capacity to be able to build and I'm thinking of all [the] infrastructure.…

GRAY: Yes, yes.

AD: …not just the actual physical building of the thing, more upgraders, and where would they be located?

GRAY: Well, I think in terms of reasonable cost control, Alberta could build one at a time at any given time. If I look at what's happened in projects, the industry has fallen into serious problems when they try and build more than one at a time. When they try and build more than one of these really large -- in the 1970s people used to talk about megaprojects.

AD: Yes.

GRAY: That terminology doesn't get used anymore, but it's still very real and you cannot run multiple megaprojects in a labour pool the size of Alberta. There's a limit of what you can do. Maybe you could run two megaprojects, which will mean one upgrader and one something else. But you can't run two or three simultaneously that require all the same skill sets at the same time because those people simply do not exist. And this is -- this is what happened in around 2008 and may happen again if the companies lose track of -- of their eagerness to get projects underway. So there's a limit of what you can do in terms of the human resources without driving your costs through the roof. No matter how good a job Alberta does on its human resources, it's still a more expensive place to build a plant than China, both because we're a little more careful about environmental regulation and because the standard of living of the workers is higher. And so if you're looking at build-a-plant in China versus build-a-plant in Alberta, you know, the plant in Alberta will always be more expensive, given the same technology.

AD: Now …

GRAY: So this is the problem, this is the biggest problem the companies are worried about -- in terms of the/their bottom line -- is do they build a plant that is more expensive than a plant in Houston? It's certainly more expensive to build an upgrader in Alberta than it is to tweak a refinery in Houston or Louisiana to take more bitumen. That.…

AD: Well …

GRAY: …and these, these are the economic judgments.

AD: And, of course the whole politics …

GRAY: Yes, yes.

AD: You know, when I interviewed Ted Cyr, who you probably knew from …

GRAY: Yes.

AD: …AOSERP [Alberta Oil Sands Environmental Research Program] -- not AOSERP, AOSTRA.

GRAY: From AOSTRA days, yes.

AD: You know -- I mean the Gulf States have the refining capacity -- they've been refining Saudi bottoms -- so that they have that capacity to deal with it. And for them it's – their/those refineries are underutilized and so they want, they …

GRAY: Yes.

AD: …want it. But of course we, now we get into the pipeline lobby, the environmental lobby, all of … that you discussed so that the Government of Alberta has been wanting to get out of just one client, the US.

GRAY: Yes.

AD: And they keep talking about getting world price and, and everything else, so they're really pushing the -- sending whether it's through now rail, whether it's through pipeline, or whatever.

GRAY: Yes.

AD: Not to the United States, but elsewhere.

GRAY: Yes. The irony of shipping by rail is the cost of shipping by rail over and above the cost of shipping by pipeline starts to look awfully close to me to the cost of upgrading …

AD: Yes.

RAY: … which is one of the interesting points that if you -- because your product is unacceptable for pipeline construction, then you're forced to resort to rail that's -- the cost of rail is such that upgrading needs another look. The difficulty the industry faces is they don't know what's going to happen next year or the year after that. If you build a 10 billion dollar investment, you're locked in for decades. It's not something you can reverse a year or two later, if conditions change. But…

AD: But you see, look at how fate/chance has ways of having people rethink things. The Lac Megantic disaster …

GRAY: Yes.

AD: …is a cautionary tale about shipping and, most recently, I mean going back to your observation about the demonizing of diluted bitumen and, you know, and shipping it by pipeline and the potential disasters that I heard on [the radio]—and, again, I don't know whether this is good science or not, you tell me -- that basically what was being shipped in those rail cars was product that came out of fracking in particular US field and they're saying that it may be more volatile. I don't know. I mean, what, have you heard this?

GRAY: Well, what …

AD: This was just a few days ago.

GRAY: What was in those rail cars was a very light material, much more flammable than diluted bitumen, so if those rail cars had been carrying diluted bitumen, it would've been very messy but there would've been no explosion and no significant fire; it's just not going to happen.

AD: But is anybody saying that …

GRAY: Um …

AD: …on the part of the industry?

GRAY: …no, because saying something is dirtier or cleaner doesn't really address some of the concerns. Most people that look at any of the statistics understand that transportation by pipeline is the safest way of transporting bulk materials. There's just nothing safer than shipping it by pipeline. The more informed people in BC, and I focus on BC because I've been -- I actually identified this problem before the US turned down Keystone -- that Canada was heading for deep problems by having only the US as a customer; that it's not -- doesn't take -- it's not rocket science to say having a single customer for a world-scale production is a bad idea …

AD: Yeah.

GRAY: …and that strategically you cannot, you cannot rely on that relationship to happen for all things be positive at all times. But now I've lost my train of thought.

AD: Oh, you were talking about BC and …

GRAY: About BC. So the more informed people say that, and they're quite right, the pipeline is safe; it's what happens after you leave the pipeline to go tankers. That's where they start to get nervous, and I would, I have to acknowledge that having upgraded bitumen products versus diluted bitumen in a tanker that hits a reef off the coast of BC, neither of those scenarios is any good if you have a major spill. So…

AD: So in a …

GRAY: … so upgrading, upgrading takes care of some of the issues but if you were to have a major marine disaster it would not be good in either of those scenarios. None of the materials we're talking about would be a positive impact on the marine ecosystem off the coast of British Columbia. And so that's what some of the more reasoned people are worried about, so the challenge for the Government of Alberta is how you constructively enter into a discussion with BC and those communities about how do you -- how do you try and minimize those risks and how do you deal with a problem if it does occur. And, I don't -- want to rely on the newspapers. I don't know if that discussion has been happening in a constructive way so that the people that are getting the benefit are -- I have a lot of sympathy for the people in those communities that are potentially at risk. I don't think the risks are very high, but I'm not an expert and things can always go wrong. So what do you do to try and deal with those risks?

AD: In terms of a risk management with respect to pipelines, I mean the technology has been proven. The number of spills resulting from metal fatigue or whatever, any range of things that can affect pipeline structures …

GRAY: Yes.

AD: …really are limited in comparison to other …

GRAY: Right.

AD: …but when you ship things, the weather and, you know, you're shipping in northern areas when you're …

GRAY: Yes. Yes.

AD: …when you're looking at the Pacific coast, I mean all of these things are much more risky …

GRAY: Oh, yes.

AD: …than a fixed pipe …

GRAY: Than a fixed pipeline on land.

AD: …pipeline.

GRAY: Absolutely, I agree.

AD: Yeah.

GRAY: And so that's why I say the -- some of the -- depending on who you talk to in BC, you get either bizarre …

AD: Yeah.

GRAY: …strange worries or you get much more legitimate concerns -- is the tanker traffic a potential risk, which is a legitimate question, I think, because shipping is the most …

AD: Still vulnerable …

GRAY: It's still vulnerable.

AD: … ike it was, you know …

GRAY: Yeah, and you can do …

AD: When …

GRAY: … you can do the best you can but the question for the Government of Alberta is what can you do to mitigate the risk or to help to offset the risk if a disaster occurs, and not just leave it to the Government of BC to pick up the pieces, for example, or to try and assure the communities that, that they won't be left hanging out to dry if there's a -- if there's a problem.

AD: Now, I want to focus some attention on the whole environment and looking at the extent of the plants and, because now of course, you know, there are websites where you can find thousands and thousands of aerial views and -- you've been focusing on -- in terms of your research and the Centre that you run, I mean it's still focused on upgrading, so in other words it is …

GRAY: Yes.

AD: …it is the mining operations.

GRAY: Well, upgrading comes to the fore …

AD: To both …

GRAY: To both.

AD: …yes, yeah.

GRAY: Now it happens, it's …

AD: Yeah.

GRAY: …it's a negligible component in the in-situ industry …

AD: Yes.

GRAY: …as it's developed. A lot of what we were just talking about recognizes the fact that upgrading is -- well, the way the technology stands now it's an opportunity and a cost for both sides of the industry. But it's, it hasn't been used significantly on the in-situ side at all.

AD: So we're dealing with the demonizing of the oil sands. We're also dealing with a distrust of science and experts, and so the fact that you're being funded by Syncrude and Imperial Oil does not give comfort to those people, you know, who hate la, multinational companies …

GRAY: Right.

AD: …you know, and also, as an academic, and as a professor, you're expected to have a larger view of things. It's not about company self-interest, you know …

GRAY: Right, right.

AD: …let's just produce oil; right; irregardless. So I'd like you to talk about some of these issues.

GRAY: Well, interesting dynamic that I've experienced is that our mission is to come up with technology that does better than what the industry is doing now, so we're not, we're not in the position of saying it's okay what's happening now. We're not saying that the industry is doing everything right; we're not saying that the industry cannot do better; in fact, we're saying we think the industry needs to do better and that's worth investing in to come up with new technology, and our mandate from Imperial Oil was, as I mentioned earlier, they did not think that the technology that they had available to them, and even now, was sustainable and defensible in the long term. So we're in complete agreement with our major industry partner that we need to do better in terms of technology. So we're not in the position of trying to whitewash what the industry is doing now; we're saying, "Here are the things that are the concerns with the industry; these are the areas where we need to do better; and so, from that point of view, almost -- unless someone has the view that there should be no further production of fossil fuels -- they have to accept that this is legitimate enterprise and that we're trying to come up with technology alternatives that will enable the more responsible use of the resource. So it's a different dialogue than you might think. We're not saying that -- we're not involved in doing environmental monitoring on the industry and trying to tell the public that it's okay. That's not our business.

AD: Right.

GRAY: We're not saying that there is no environmental impact. We're saying let's come up with process technologies that will reduce the impact. If we come up with those technologies, then obviously, industry will have to do the -- demonstration that they really are better and that there aren't unforeseen consequences. But, at this stage, we just have to do better in terms of what we know is the main problems with the existing technology. So, on that basis, I've had no trouble recruiting academics into this enterprise because they see the intellectual problem, intellectual challenges, but they also see the social benefit of coming up with better technologies to use this enormous resource.

AD: Now, of the three streams of research that COSI is focusing on, one of them is to do with tailings …

GRAY: Yes.

AD: …and I think that the tailings consortium is now part of COSI, isn't it?

GRAY: Yes, it's now the -- it's called the Tailings Environmental Priority Area …

AD: Exactly, and …

GRAY: …within COSIA, yes.

AD: And it is a part of the University of Alberta?

GRAY: Not quite.

AD: Well, not quite.

GRAY: No. The University of Alberta will probably be a member of COSIA in some way …

AD: Okay.

GRAY: …shape or form, whatever that means.

AD: Okay.

GRAY: COSIA is primarily an industry consortium to share intellectual property and share results. The University of Alberta is primarily a research performer and idea generator …

AD: As, as a part of that, yeah…

GRAY: …which is why we're still having a little bit of a dance as to what's the relationship between the university and this industry consortium; we want to work together; it's just a question of definition of roles and responsibilities. We're not a -- we're not a company, so if we join this group, we shouldn't be joining on the same basis as any company joins it …

AD: Okay.

GRAY: because that's not our role and we're not about to say that everything that these companies is doing is wonderful. That's wildly inappropriate.

AD: So we go back to my question about …

GRAY: Yes.

AD: …that you as -- as a professor and as an academic, of course, you're expected to take this larger view.

GRAY: Yes.

AD: And that you're not apologists for the industry.

GRAY: No, and we're not, we're not -- well, I do resist the frequent request to criticize the industry in public because that's not my role either. That's what they -- I get media calls about regularly because they want somebody to comment on the industry and the industry usually doesn't say very much beyond their prepared statements. But no, as a professor, I have to tell the industry what I think they can do better and what I think are the problems with what they're doing, and for the most part they agree a hundred percent with the criticisms that anybody would level at the industry. When you talk to the people in the mining and they're worried about tailings, they would like to come up with a much better way of -- they'd prefer not to have to shift away from using water, but they'd much rather not accumulate large volumes of tailings. They just haven't come up with a method to do it that's reasonably cost effective.

Now that's where the debate changes with time; what constitutes cost effective? Twenty years ago what was cost effective is not the same as what people think is cost effective now because, now, the companies are starting to see more what is the real cost of accumulating millions of cubic meters of tailings; what's the real liability of that? They've changed their thinking about what the real cost of tailings management is.

AD: But you see, you had someone like Ted Cyr who was involved in funding so many of the research projects …

GRAY: Yes, yes.

AD: …through AOSTRA, and he basically said that 20 years from now tailings could become a resource.

GRAY: Possibly.

AD: And that -- and we go back to your science and improving processes.

GRAY: Yes.

AD: That all sorts of things could -- could still be extracted from the tailings ponds themselves.

GRAY: Potentially, although I'm not sure that the prospects are great. There's a -- I would say it's possible but unlikely in my opinion.

AD: Okay.

GRAY: Possible but unlikely, and one of the reasons is an area that's much closer to my own work, which is, in the last two or three year,s I've been getting much more involved in what bitumen does on these mineral surfaces …

AD: Okay.

GRAY: … and how they interact and what's happening with the -- you mention nanoparticles; there are nanoparticles in bitumen. What they do on these interfaces, and what the implications of those interactions are -- one of the problems in the oil sands is, once you start sticking bitumen onto things, you never get it off again. And this is a huge issue for mineral recovery from the tailings. You can get potential minerals but, unfortunately, they're all contaminated with bitumen, and in some cases that negates the value. So bitumen is the sticky point, literally.

AD: Literally. Well, you know, it's a nice transition because I was going to ask you about the implications of nanotechnology and the facility at the University of Alberta, and the capacity that you have there.

GRAY: That's had some, some significant impact in indirect ways primarily. A lot of the equipment that the nanotechnology institute has is focused on relatively hard materials -- some of the very high-end microscopes and so on. Ironically, where the Nanotechnology Institute's capabilities have had the biggest impact is some of their simulation capabilities of being able to simulate how molecules interact, how nanoparticles behave. We've had a lot of collaboration between the Centre for Oil Sands Innovation and the modelling group at MIT, because they've developed some tools that are extremely valuable based on, I guess, the IT side of nanotechnology, rather than the hard experimental side. So we've had some very strong interactions there and they've helped to make some significant advances on how we understand the behaviour of how these large molecules interact with each other; how they cluster together to form nanoparticles; and how those nanoparticles start to interact with surfaces. These are areas where the simulation tools coming out of nanotechnology can make a real contribution.

AD: On the process side.

GRAY: On the process side, and also understanding some of the fundamentals. Why is it that when you get bitumen contacting a surface it's so hard to clean it off again? These are questions that you can interrogate experimentally to a point; we can also use simulation to try and understand better the physics of what's happening.

AD: Now, clearly environmental criticism is having an impact on not just the image of the industry, but also government -- I mean, we've seen the governments of Canada and the governments of Alberta looking at more joint things, you know, agreements on water. I mean this is now …

GRAY: Yes.

AD: … a focus. It used to be that government was an active partner in anything that offered economic development; I mean, grew the GDP, created jobs, you know those things. But the environmental criticism aimed at the oil sands has resulted in new concepts around the "license to operate," and that it is being applied to the oil sands industry and perhaps less so to other types of industrial activity. For example, other open pit mines …

GRAY: Right.

AD: … you know, in other parts of the world. Do you want to talk about that … in terms of these circles in which you move. Is this being taken on, on-board and what discussion is there around that?

GRAY: That's not the area where I'm primarily focused because my focus, as you've mentioned, is process technologies.

AD: Yeah.

GRAY: And the Centre that I direct is focused on process …

AD: Yeah.

GRAY: …technologies. So we always, when we look at alternate technologies, we do look at what are the potential impacts of those changes or using radically different approaches on the environment, at least to a first approximation. Are you introducing something that is a key issue that is unacceptable environmentally? So we always do a screen on that basis; we always worry about that. To some extent though, what the -- in terms of the impact of the oil sands and the international attention, it's been a combination of factors, I think. Part of it is, is simply you have people looking at pictures -- and making judgments -- that have never in their life visited an open pit mine and have no context for industrial operations. So you go and fly-over an open pit mine at Syncrude and you see, depending on your viewpoint, you see the scale of the industrial operation or you see this huge scar on the landscape, depending on your mind set. You don't see what it looks like in 50 years; you don't see what's the mine closure plan; you don't see what an open-pit mine looks like 50 years later; you don't see any of the context; and you don't, you don't appreciate the time scales involved.

So for the mining industry, this is one of the characteristics and, unfortunately, because of tailings, they haven't reclaimed any of the original mines yet. Suncor has reclaimed one of their -- the original tailings pond; Syncrude has reclaimed some of their mine waste dumps, but none of the original two mines have been reclaimed yet. When that's done, that would be a showpiece for the industry to say "This is what it really looks like after the reclamation is finished." We're not that far away. I think with the way it's going within five years you'll be able to drive up, I think it's highway 60, and see reclaimed land on either side instead of actively-reclaimed open pit areas with tailings and so on, spraying around and it's sort of lunar landscape.

Instead, you'll see more of what the end-landscape would look like and that gives a very different impression. So part of the problem is people are forming judgments that have no basis for comparison, and they're looking at a point in time that is the worst case in terms of what it looks like in terms of the landscape. It looks really nasty while you're in the middle of reclamation; it looks much better when you're actively mining because then it looks like you're being productive, and it looks much better after the reclamation when things are green and growing. And so right now is the "worst case" time-period for the major mine sites at Syncrude and Suncor.

[In] five-years-time, with reclaimed land on either side of the highway, it's a different dialogue because now you have a showpiece. This is what a mine looks like when we're done. Now you can, you know, look at it, judge for yourself -- is this an acceptable outcome? How does this make you feel? As opposed to similes that I hear from people in British Columbia -- this is like mortar or whatever analogue they like to use.

AD: Yeah. Yeah.

GRAY: So that's one issue. The second issue is, in retrospect, completely predictable but completely not dealt with well by the Government of Alberta and the Government of Canada, which is when you've got one plant, there's issues; when you've got two plants, you've got issues; when you get three, four, five, they start to multiply and you start to get much more regional impact to an extent that you didn't anticipate before. And, so, one of the legitimate criticisms of the Government of Alberta and the Government of Canada is in terms of their evaluation, monitoring and all those other issues. They were not planning well enough for the cumulative-impact regionally …

AD: Yes.

GRAY: … as opposed to the project by project.

AD: Yeah.

GRAY: At the same time, the idea that this would be a pristine wilderness area around the perimeters of these plants was completely naïve. Now, unfortunately, I think, and I haven't looked back on this, but to some extent I think this may have been promoted a little bit by the Government of Alberta in some of its pronouncements that they did not say, you know, how does this compare to a major urban area, which it now is. This is a major urban and manufacturing centre. What's the water quality in the Athabasca River compared to the North Saskatchewan River? Well, I think it's actually quite a bit better, but the comparison that's being made is not Athabasca River versus other inhabited areas but how does that compare to the nearest pristine wilderness?

AD: Well …

GRAY: And that's a very difficult standard and I'm not convinced it's an appropriate standard.

AD: Well, from people that I've interviewed on the industry side, I mean in terms of the water quality of the Athabasca, when you think that bitumen is naturally occurring …

GRAY: Right.

AD: … in it anyway, that it is more monitored than any other river system in the country …

GRAY: Yes.

AD: … and that it's cleaner than many river systems.

GRAY: Yes, but cleaner is not good enough for people that think it should be pristine …

AD: No, that they want pristine, yes.

GRAY: … wilderness. So some of my colleagues at the University of Alberta do not seem to understand what I call the "myth of zero."

AD: Yeah.

GRAY: In environmental matters today, there's no such thing as zero concentration; it does not exist. Our techniques, for the most part, are so sensitive we can always detect a contaminant at some concentration. I'm exaggerating a little bit, but you understand my point that with …

AD: I do.

GRAY: … with modern analytical technology, our ability to measure far below safe levels is very real. And so the question is not "What is the concentration," but "Is it a safe concentration? " Twenty-five years ago the debate was, was it measureable or not?

AD: Yeah.

GRAY: Now the debate is, "Is it safe or not?" And that question, I think, has been totally lost in the minds of some of my colleagues that like to make pronouncements on this that they're not bringing the safety aspect at all; they're bringing an unattainable standard of zero concentration.

AD: Yes, and that the capacity to measure the process has grown enormously …

GRAY: Yes.

AD: … and so then what is significant?

GRAY: Right, and what is unsafe and what is different …

AD: Yeah.

GRAY: … from the pre-existing conditions …

AD: Yes.

GRAY: … in the case of hydrocarbons in the Athabasca River.

AD: Mmhm, yeah.

GRAY: I've canoed down the Clearwater River …

AD: Yeah.

GRAY: … which is a beautiful river, but as you get close to Fort McMurray, without any industrial development at all, you see hydrocarbons in the river that are naturally bubbling up from the sediments …

AD: Yeah.

GRAY: … along the banks of the Clearwater, hydrocarbons are a part of that environment and they have been for the last 10,000 years.

AD: Well, and I ended up writing -- there was an article in the *Edmonton Journal* quoting someone, an aquatic specialist at the U of A, and the statement implied that the bitumen in the river was the result of seepage or something, and so it prompted me then, as a historian, to write a letter to the *Edmonton Journal*, which became a featured letter …

GRAY: Yes. Yes.

AD: … that was quite lengthy, where I quoted various explorers, you know, who noted the bitumen.

GRAY: Yes, of course.

AD: We can't -- bitumen found and so on.

GRAY: And they -- and you would see -- they would see little oil slicks on the water.

AD: Exactly.

GRAY: And that's exactly what I saw on a part of the Clearwater River that was completely remote.

AD: Which had nothing, and….

GRAY: It was remote from any industrial development.

AD: So, again, I mean as a part of [Oil Sands Oral History Project I had] the privilege to interview Norbert Morgenstern, I mean Hardy and Associates, of course, designed the first tailings pond -- the Tar Island Dyke.

GRAY: Yes, yes.

AD: And that -- it's the best of earth science, I mean that's again a strong suit for the University of Alberta, so that the whole notion of seepage, I mean, has been dealt with in a very …

GRAY: Oh, yes.

AD: … responsible fashion. So that, of course, now David Schindler is focusing on the particulate matter as resulting from the cokers that is found in rainwater, snow, whatever, but, as you said, you compare that to any other urban centre and, particularly, you know, the eastern US where you still have coal-fired power plants, I mean how does the carbon footprint of the Fort McMurray area differ from that of a big industrial city: Pittsburgh, New York ….

GRAY: Right.

AD: … you name it. But those comparisons are not made.

GRAY: No, and the other part that's being lost is, if you go back to the Brundtland Commission definition of sustainability …

AD: Yeah.

GRAY: … the definition of sustainability is what are you doing that impacts the ability of successive generations to use that land? So, obviously, with any non-renewable resource, once you've taken the bitumen out, it's gone. But are you leaving contamination at a level that is persistent for generations or is this relatively transient, and it's not an issue in the long term? And that's the other part that's being lost. When you're arguing about levels that are below drinking water standards from the Government of Canada that are due to industrial operations that are time-limited, what is the real long-term sustainability issue? Is there an issue of acute problems now? Are there long-term issues? But those questions are not being asked; it's "Is it zero or not," and the consideration doesn't seem to go beyond that.

AD: So, in other words, in terms of the environmental critics, they have been successful through the media campaigns in sensitizing, well, anyone who reads or listens or watches TV, that this is a terrible thing, and they've also really frightened both levels of government in Canada and the United States, I mean the …

GRAY: Yes.

AD: … Obama administration. They have been successful with respect to that.

GRAY: True.

AD: So, you know, it becomes obvious that the work of the Centre that you head, I mean in terms of improving processes, and the issues around tailings and so on, becomes even more important. And maybe you can talk about the role of science in the next 20 to 30 years.

GRAY: Well, I guess if I wanted to give an optimist view, what I would foresee is in the space of three to five years, which is the usual time to go through piloting and scale-up; we would have new, at least one new technology for extraction and at least one new technology for upgrading that would be ready to go to the next stage of commercial development. That's my hope. It's hard to say if we'll get to that, but we're certainly trying, and that's look -- if I look at the portfolio of what we're doing, I think the prospects are good that we will have some very different technologies available than what the industry is using right now. Whether it's completely better, that will take longer to see because we do have to worry about the environmental impact, and look at other factors to see whether these alternate technologies are robust enough, and scalable enough to be used on a massive scale.

AD: So your hope then is to have more and more efficient processes that potentially will have enabled the industry to improve its performance in a whole range of areas.

GRAY: The two …

AD: Would that be fair?

GRAY: Yes. The two main areas where I think we can make improvements are on -- if I look at non-aqueous extraction or water-free extraction to get away from wet tailings, and to me, that, of all the work we're doing, that's the best single-prospect for dealing with water and tailings issues is just don't make wet tailings in the first place. That, to me, has a simple appeal that is a powerful motivator and the science and technology that we're developing looks very, very promising. So to me that's much far likely than finding a magic, or magic bullet for how to get water out of the tailings once you've created tailings. Once you've done that, everything is stacked against you. And this is what the industry has been butting its head up against since the 1980s when they first started putting a lot of effort into looking at tailings technologies. Now, the industry has been at it for 30 years to try and come up with better methods of getting the solids and the water separated ….

AD: Well …

GRAY: … in the tailings ponds.

AD: I mean I think that that would address two criticisms, wouldn't it? About the …

GRAY: Yes.

AD: … growing tailings ponds and …

GRAY: Yes.

AD: … secondly, water use.

GRAY: Right, it means you're not trying to contain -- with all respect to Norbert Morgenstern and his colleagues, you don't need huge dykes …

AD: Yes.

GRAY: … to contain the tailings; you don't have to worry about seepage …

AD: Yeah.

GRAY: … although you do have to worry about different seepage; now you're worried about seepage out of a reclaimed mine landscape.

AD: Yes.

GRAY: There's still seepage issues. You still have to pay attention to that to be environmentally responsible, but you don't have the volumes of material. You're trying to manage the way the industry is doing it now. You just have natural groundwater flow you have to worry about. You're not pumping large amounts of river water into containment ponds and, ultimately, tailings ponds and then worrying about seepage from those. You get out of that huge magnification of volumes that the tailings approach that the industry is using now gives you. And then, on the upgrading side, I think with some of the novel catalysts that are under development, we can look at having much better control over the molecular structures, and significantly reduce some of the costs associated with upgrading.

What we can't change is the fundamental fact that bitumen is a fossil fuel material and, when you burn it, it will generate carbon dioxide, and so there's some fundamental barriers that anything we do will not budge. So in terms of greenhouse gas emissions, we can whittle away at those but the bulk of those are still there when the end-user uses the fuel. And that doesn't change at all with anything that we're doing; so if you're talking to someone whose biggest concern is greenhouse gases, we can nudge it so that it's closer to other forms of energy, but we're not going to eliminate it; we're not going to make it CO2 neutral.

AD: Well, it was interesting that, and I thought when is this going -- when is someone going to raise this issue? The whole electric-car stuff.

GRAY: Yes.

AD: And the implications -- yes, I mean, it sounds wonderful but then you look at how electricity is generated and that, you know, supposedly, ideally water-generated electric power is wonderful, but

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look at the devastation of James Bay, you know, that huge hydroelectric -- the Bennett Dam, I mean …

GRAY: Yes.

AD: … with implications on the Peace River system, you know, in terms of flooding and stuff. So, you look at those major power projects in Manitoba …

GRAY: Yes.

AD: … the huge …

GRAY: Huge areas that are flooded and …

AD: Flooded.

GRAY: … changed. And, in many parts of the world; the United States is one of the worst offenders. Electricity means significant amounts of CO2 from coal.

AD: Yeah.

GRAY: And that, to me, is the most irritating part of the debate in the US is -- they completely ignore what their real CO2 footprint is and why, and then they go chasing electric cars and it's totally bizarre because they are so far in the hole on electric-power generation and CO2 and now they're talking about running cars on electricity generated from coal predominantly. They don't have hydroelectric resources to develop. It's just not going to happen. And so, it's a totally bizarre debate.

AD: But you know, you're being conservative in terms of research gains I think because when you look at the last say 30 years in terms of oil sands development, in terms of the process enhancements …

GRAY: True.

AD: … that if you, you know, if you move out 30 years with the mines that you have at various …

GRAY: True, but I'm trying to be respectful of the fact there are some fundamental barriers …

AD: Okay.

GRAY: … so I think we can do appreciably better on upgrading …

AD: Yeah.

GRAY: … and the biggest benefit of that would be reduced cost, higher yield and lower capital investment.

AD: Right.

GRAY: We can dramatically, I think, shift the environmental footprint of the extraction technology.

AD: Right.

GRAY: And that's a big step change. But we can't change the fact that a big environment issue is CO2 …

AD: Yes.

GRAY: … and that we can't negate that. There's nothing, nothing possible within the portfolio of COSI that would change the fact that that carbon is all fossil carbon. So depending on the concerns of the -- in terms of the environmental impact, you have to be very clear -- what can you deal with and what is still going to be there?

AD: Now, I want to go back to your current position as, as Vice-Provost Academic and Associate Vice-President Research. Now the university has cultivated some international partnerships and I'm thinking specifically in this area and do you want to talk a bit about that? I'm thinking of Germany, I'm thinking of France …

GRAY: Yes.

AD: … China, Japan, you know.

GRAY: Yes, the university -- well, obviously if you look at the University of Alberta, one of the standout capabilities of the university as a whole is research on energy, much of it based on oil sands, as we've been discussing. So that capability is what was at the root of the discussions with the Helmholtz Institute in Germany. That was the basis for some of the discussion, a portion of the discussions with France, although not to the same degree. We're working on relationships in China, again, with that as the primary basis as a starting point for discussions, and also in Brazil, and potentially in one or two other Latin American countries where hydrocarbon development is a primary interest. So this is a recognized international strength of the University of Alberta; it's a natural starting point for some of our international collaborations.

AD: The other thing is that I gather that you and Jacob Masliyah co-authored -- well, first of all, you developed special courses, so do you want to talk a bit about that?

GRAY: Yes. Back in the 1990s when we were -- it was actually in the late 1990s we both were industrial chair-holders both collaborating strongly with industry. We realized that one of the gaps was how to transmit the information that we were generating in our research and our understanding

that we were teaching the students in the classroom to the industry. And so we actually did two things at that time. One was we developed a short course on oil sands extraction and upgrading that we first offered in 1998 and has now been offered many, many times to thousands of participants from all across the oil sands industry. And we also developed an oil sands engineering program within chemical engineering here at the University of Alberta to put in place two courses to make sure that we were offering that same material to our own students.

And so we've taken a major, major effort on educational translation to undergraduate students and graduate students within the University of Alberta, and to people that are coming in from industry with many, many different backgrounds: some engineering, some accounting, you name it, and giving them an appreciation of some of the technology drivers for the oil sands industry.

We try and link, in both our courses at the university and in the short course, what are the fundamental rules of physics and chemistry that govern this; how does that lead to the technology, and then technology plus economics gives us the industry that we see today? And what are the links that run through that thread and why do companies choose particular technologies under particular circumstances? How to they compare? How are they different? What is the technological landscape and why? And one of the most interesting questions is, is what could you do better given the starting material that we have?

AD: Now, are these delivered -- some of them delivered in Fort McMurray, or where are they delivered?

GRAY: The large majority are given either in Fort McMurray for the companies in-house, so in Fort McMurray we deliver the course for Suncor, occasionally for Syncrude, CNRL and Shell. We also give the course in Calgary, both by appointment for individual companies and for a general audience. We rarely do it in Edmonton. Every-so-often we do one in Edmonton for a particular company, and we've done it internationally. We've done it in Houston; we've done it in Amsterdam by appointment. And so it's been not quite a global effort, but a significant international educational effort.

AD: Aren't you also collaborating on a book, like an Oil Sands 101 type of thing? I think that's one of Jacob …

GRAY: We have -- yeah, we …

AD: … started.

GRAY: … have two books. Jacob has now finished a major handbook …

AD: Okay.

GRAY: … on extraction working with Jan Czarnecki and Zhenghe Xu as co-editors. So they've got the first volume out and the second volume is in the works. I'm working on a third book, which is

due out this year with the University of Alberta Press on upgrading. So coming out of our research and the short courses, we will have a full range of reference material on extraction and upgrading of oil sands.

AD: And I can't imagine that there are many other resources like that out there.

GRAY: Um, no, very few. Not, not that span, the full range from the basis science through to the technology and the economic drivers, no; not at all.

AD: Now, in terms of your years at the University of Alberta, I think it's 30 years?

GRAY: Almost 35.

AD: Thirty-five years. Okay.

GRAY: Thirty-five in October.

AD: Okay. Can you talk to me about other colleagues that you think we should be interviewing, and students who have gone on….

GRAY: Gone on.

AD: … to work in the industry and distinguish themselves in some way?

GRAY: That's a good question; other faculty members. Well, I guess one person who would have an interesting perspective would be Zhenghe Xu, who has taken over Jacob Masliyah's activities. I think he'd have a very interesting perspective on how that whole effort, which is primarily oil sands extraction, how that's -- where he sees that going now that he's taken it over from Jacob. Jacob, I'm sure, has given you an opinion.

AD: Yes.

GRAY: Zhenghe would have an interesting, interesting alternate opinion. Another person who brings a very different perspective would be John Shaw, who …

AD: I've interviewed him.

GRAY: Oh, you've inter -- oh, so you've already done John …

AD: Yeah.

GRAY: … so you've done that.

AD: Well, … and of course when he talks about liquid, liquid, all of those things, it resonated with his interview because, as he said, he is totally out of the box and he challenges the …

GRAY: Yes, yes.

AD: … the norm for doing things. Yeah?

GRAY: Yes.

AD: Good.

GRAY: Former students? Let me think. Now we're getting into a younger cohort. Well, the one person I would think of would be Harvey Yarranton at University of Calgary, who holds a chair in -- related to oil sands -- but I don't think that's the title; it's more general on petroleum. But he would be somebody who -- his work was with Jacob Masliyah and he would have, I think, a very interesting perspective on how the industry is developing and how research has developed over the last decade.

AD: It's interesting being in a -- doing a project like this and interviewing people who began to contribute in the sixties in various ways and, of course you're really part of the younger generation with respect to that …

GRAY: From that perspective, yes.

AD: Yes.

GRAY: Yes.

AD: And, you know, the different eras in terms of the research and …

GRAY: Yes.

AD: … and the technology.

GRAY: Well, I've been in it long enough in my -- well, through my education and career I've been now through two complete cycles of, well, certainly two peaks of intense interest and one big lull in the middle, and I don't know whether we're headed for another lull or whether -- you never know what the future is going to bring. But you'll be interviewing Alan Mather; Alan Mather always says that when the wheel comes around for a second time, it's time to retire. And occasionally I get that feeling, but to some extent you can see some of the patterns potentially repeating and so I guess to my mind a big question in terms of the future is, is are we going to see a period of lull where, where the level of intensity goes down.

The industry is there; the industry is going to continue, but will we see a loss of acceleration? Will we see consolidation, companies focusing on rather than building another plant, just operating what they've got already rather than the expansionary mode that we've seen dominating the last decade.

AD: Now, I mean, in terms of the projections of energy self-sufficiency with respect to United States and the re-emphasis on conventional oil and re-evaluating the reserves and all of that, do you think that that could impact on …

GRAY: It could. I'm very nervous about wild extrapolations. And so what you're seeing in some of the pronouncements about the US are wild extrapolations, in my opinion, where they're taking a development in North Dakota in one particular geological basin of very unconventional light oil, but it's not conventional oil at all, it's -- in terms of the hydrocarbons -- it's nicer than bitumen, but in terms of the geology, it's extremely challenging; and then extrapolating that ad infinitum until you see something happening. I don't like those extrapolations at all because they're not well-founded.

And so the projections that the US would be self-sufficient by "X" years involves so many assumptions about a phenomenon that the physics aren't clear at all; how you're getting liquid hydrocarbons out of these shales …

AD: Yes.

GRAY: … how sustainable that is; what kinds of yields you can ever hope to get. Uh, those are huge questions.

AD: And what the environmental implications of that are.

GRAY: I'm leaving that aside. The environmental implications are substantial …

AD: Yes.

GRAY: … but just the feasibility of it on a sustained basis …

AD: Yes.

GRAY: … is, is not -- the gas is another story, so gas out of shale makes far more sense. In very simple terms, getting a methane molecule out of matrix is much, much easier than getting a molecule of any liquid hydrocarbon. And so, from the point of view of physics, if you've got a very tight rock, getting methane out, to me, is orders of magnitude easier than getting octane out. And that's the fundamental barrier -- that's why I don't get really what the prospects are for oil from shale, which is what is driving the bullish pronouncements out of the US. It's not shale gas -- shale gas pretty well defies the economic scene to be understood. Getting oil out of the shale, the economics don't seem to be understood well at all, and the prospects are even more confusing.

AD: Well, because, you see, I mean in terms of bullish development of the oil sands and whether it's upgrading here or shipping out that people say, "Well, you know, there may not be the market and that the Bitumen Bubble …

GRAY: Yes.

AD: … so-called is an example of this and that Alberta could be stuck high and dry and the companies could be stuck high and dry with …

GRAY: Right.

AD: … the investments. Do you think there's any possibility?

GRAY: Well, I think there's a possibility of that if you don't get off-shore. I'm not so convinced about shipping to eastern Canada as a prospect. It's technically feasible; whether it really gets you out of the market bind is quite another question. But, if you can't get to Asia, you're limiting your prospects, in my opinion, and I've thought that for quite some time, because it's -- as a national strategy having only one customer is a bad idea; for any commodity; for any product, for that matter. If you have the potential and you have willing interest in Asia -- it's not that the Asian countries are not very interested, they just say, "Well, where's your pipeline?" Without a pipeline there's nothing to talk about.

AD: Now, do you think that the companies, in view of the opposition in the US and the Obama administration's, you know, cold-water pronouncements …

GRAY: Yes, yes.

AD: … and also the hearings in BC, you know, in all of that, do you think that if you were a betting man, how do you think those would end up?

GRAY: I vacillate. The companies were caught totally unprepared for what happened in the US as far as I can see, even though some of them have had orders in the US. I think they were totally blindsided by what happened with Keystone. Their attitude was the path of least resistance at the US. In some cases we/our head offices are US-based. This is not a problem, that's the natural path and they were not willing to say what if that goes sideways? What is the risk of that not happening? And so they didn't, I think, take a strategic view and so they took a short-term view of everything as it has been and will be as it has been, and that will be okay. They didn't really assess the risks, I don't think. Now they know the risks. How they view Asian markets -- I think they have to be much more serious about trying to access Asian markets.

How you break the potential long-term deadlock in BC is a question that I can't answer. How do you break it open so that you have community support? In my opinion, if the pipeline proposal, any/either of the pipeline proposals, but particularly the one to Kitimat, if you can get the local Aboriginal communities on side, then it will overturn whatever opposition comes out of the Vancouver area because it's irrelevant. If you can get the local people to support it, that to me is the key, and particularly if you get the Native bands to support it, then you have a prospect of moving the project ahead. If the Native bands are opposing, it doesn't matter what the NEB decides, doesn't matter what the Government of Canada decides, you have a political minefield for social resistance.

AD: But is this kind of cultivation happening?

GRAY: I don't know. I don't know …

AD: Because, I mean …

GRAY: … at all.

AD: … you look at in terms of Fort McMurray, Fort Mackay, I mean it's taken years …

GRAY: Yes.

AD: … to, to build those …

GRAY: And, and …

AD: … relationships.

GRAY: So I don't know what, what it would take. Over most of the pipeline route, the real risks to my mind are exceptionally low; the disruption is temporary and limited. I'd spent Monday driving along the pipeline right-of-way from Jasper through through Jasper National Park and this is not a long-term problem in the landscape …

AD: No.

GRAY: … where that pipeline project went through about three years ago. So that puts it in perspective going through a national park to see what the real impact is. The challenge is two-fold. One is how do you overcome some of the rhetoric from some of those Bands about perceived "huge" risks versus "negligible" benefits? In reality, they're probably right about the benefits; I think they're grossly overstating the risks, except for the Haida where they're concerned about marine spills and …

AD: Yes.

GRAY: … there they have a legitimate …

AD: And that's legitimate.

GRAY: … concern. Even if the odds are low, how are the proponents and how are the governments dealing with that risk …

AD: Yeah.

GRAY: … to, to try and put their minds at ease.

AD: So really, the landlocked Bands, I mean that the whole issues of economic benefits have to be seriously tackled.

GRAY: They have to be, yes.

AD: As they have been with respect to the whole Athabasca -- well, not with every Band …

GRAY: Yes.

AD: … but certainly the Athabasca region with some of the …

GRAY: They have been. Unfortunately, if I look at the Mackenzie Valley pipeline as the example, then my bets would be off because the prospects are exceptionally dim.

AD: Yeah.

GRAY: That even after 30 years of discussion and significant changes in how Bands were involved in that project, it still didn't go ahead because of issues in terms of community approval.

AD: But you see, I think you -- but you have some of those players -- now they've changed their mind; they want …

GRAY: Some do.

AD: … economic …

GRAY: Yes.

AD: … economic activity …

GRAY: And …

AD: … and they feel that the whole Berger Commission in the end has not served them.

GRAY: That could be, and I'm not that up on the Mackenzie Valley pipeline; I just know that even after getting some of those major barriers overcome, there was still enough residual groups to stop the project or slow it down to the point where now, for other reasons, it's been cancelled.

AD: It's not economically feasible.

GRAY: But its approval process was not straightforward.

AD: No.

GRAY: And there was a long, protracted period that ended with the cancellation of the project where, in my mind, it clearly demonstrated that the land issues and the community and the Aboriginal issues had not been fully sorted out …

AD: No.

GRAY: … for that particular project. So if you have the same situation in BC where you get 90 percent of the Bands on side and 10 percent don't agree, then you're done; it's over. It's the same, the same potential problem. You can get 90 percent happily involved as economically benefitting participants, but you have to clear all the roadblocks to start construction.

AD: Now, what do you make about the whole concept of license to operate and other similar, you know, corporate responsibility …

GRAY: Yes.

AD: … stewardship.

GRAY: Well, I know that companies are talking a lot about it. I don't know whether they really get it yet and …

AD: Yeah.

GRAY: … and so I see different -- if I look at the Gateway, Northern Gateway pipeline as an example, I get different stories. I get stories about the effort that Enbridge is putting into community engagement and I hear comments about how what they did with local communities was totally wrong headed; and so I don't know what the right answer is; how you build up trust and engagement and a sense of mutual benefit with communities that are sceptical. And that's the reality going in. They're highly sceptical. Part of that has nothing to do with pipelines, nothing to do with energy, nothing to do with oil, but just due to history of provincial and federal relations with those groups. That's the history and the baggage that come into these discussions.

AD: Now, a final question. You know, the notion of the "Bitumen Bubble," in other words, these resources not getting to market, the province having to rethink their revenue for projections for this year and next year, and then the cuts to the universities and colleges, and now -- what does that mean in terms of the university's capacity to continue to develop excellent programs?

GRAY: Well, the university is a fragile creature in many ways. If you don't have the leaders intellectually, you can't move ahead, and if you side-track them or if they get distracted, you can't move ahead. So you need to have the right people with the right mental attitude in order to make these kinds of discoveries, and that's the fragile aspect of a university. If you drive those people away, worst case, then it's over; then you just can't do it with the next tier. You can always fill a position but you're not going to fill it with somebody who's going to really take you and lead you forward in a particular area of research. And that's what I think people that don't know universities

miss -- is they confuse hiring somebody with a PhD versus hiring somebody who really has that capacity to move it forward. It's that, it's that exceptional whatever the percent is, 10 percent, one percent, something in that range of the researchers in university who really have the impact. There's a lot of very good people but it's very few people that have the spark that are really able to make things happen and really take a leadership role.

AD: Well, you see that, I've asked you that question for two reasons: one, because you are the VP Research …

GRAY: Yes, yes.

AD: … and b) you are also the head of this Centre …

GRAY: Yes. And so….

AD: … which draws on not only home-grown-talent …

GRAY: Right.

AD: … but international talent.

GRAY: Yes. So the most damaging aspect is not actually -- well, we'll see what the budget cuts really mean, but the most damaging aspect is the sense of making the researchers, the professors feel that they're not valued.

AD: Mmhm.

GRAY: And if they don't feel -- there's -- it's not just about dollars and cents; it's largely about perception and value. These are people that are not motivated primarily by their paycheque; they're motivated by curiosity, by many other things -- academic ambition -- but it's not primarily dollars and cents; it's not a bottom-line type of mind set that makes a good researcher; and so if you give them the sense that it's over, that things are going downhill …

AD: Well …

GRAY: … that you're not going to invest in this area and that it's not -- and if you're doing something like an "across the board" cut for the entire post-secondary sector, this suggests that this is not a province that values these kinds of activities. That's the danger and that's the risk.

AD: And now the university statement moving into incentive packages for early retirements, I mean that -- I mean you look at Jacob and of course he was emeritus and …

GRAY: Yes. Yes.

AD: … and continuing this work. So, you know, that it does have, it does have implications.

GRAY: Yes, it does. So all of these things have implications in terms of morale, in terms of how people are focusing their mental efforts, and they're all complete distractions from what they're here for.

AD: Because, you know, having interviewed a number of people within the various disciplines, not just engineering, but geology and so on, that have resulted in this excellence …

GRAY: Yes.

AD: … in oil sands-based research, it's, it's how do you retain that?

GRAY: Right.

AD: And it's peak, isn't it?

GRAY: Yes, how do you …

AD: And it takes years to build it.

GRAY: It does, and so you need, you need the right people and you need the right partners, and you have to retain both. So if you turn off your people or if you turn off your partners, you're no longer able to move ahead the same way at all. That's the problem.

AD: I don't want to end up on a negative note, so I mean is there any other -- anything else you want to talk about?

GRAY: Well, I guess if I could take that and turn it around -- our provincial government's funding has gone through cycles as well, so I guess I've been around the university long enough to know that there are ups and downs. The province, in its finances, has ups and downs. The extent -- the only unusual thing about the past cuts is it seemed to focus on post-secondary education and not other areas of provincial activity. That was the most disheartening thing for the university, not that the province had hard times, everyone got that; but the post-secondary sector was singled out as the …

AD: But it was, but your point about cycles -- the Paul Davenport era.

GRAY: Yes, yes. But, but …

AD: Huge cuts -- 35 percent.

GRAY: Significant cuts, but across-the-board in the public sector, not just the universities. And so that's the difference that we're seeing now. We're not seeing significant evidence of the province tightening its belt across-the-board; we're seeing budget increases in some areas and cuts in others,

so that's a different message. So the Bitumen Bubble may or may not materialize; the Bitumen Bubble that they were talking about in the fall has largely disappeared, it was a …

AD: Exactly.

GRAY: … it was a transitory issue. The longer-term issue of having more bitumen that you can ship is still very much with us, but that's a multi-year issue, and if you're stuck with rail transport, that's the worst case scenario in terms of transportation. But the issue from the -- in terms of the province and the federal government -- is how did they value research and development and education, and how do they support it and how do they draw that balance between the ups and downs of government revenues versus an enterprise in universities? It's a very long-term investment. To get a faculty member to the point where they're able to take a leadership role takes at least a decade. It's not a one- or two-year thing, and you can't bring people on and then let them go again. I used to hear from researchers, it takes you five years of research before you start asking the right questions, and probably ten years before you're ready to start telling other people what they should be asking. It's a long-term proposition, so it takes time to build up that enterprise. It doesn't turn on a dime.

AD: And maybe some final summative remarks about academic research. I mean you've seen it. You will, as a serious student, you will have experienced it first at the University of Toronto and the lifeline of some programs, the AOSTRA funding, and so on. Maybe some remarks around that.

GRAY: Yes. I think the important thing is the challenge for both universities -- I think it's as much of a challenge for the university administration as it is for governments -- is the balance between trying to set direction and trying to enable excellence. So to what extent do you try and pick your strategic directions and go after those, and to what extent do you take a more laissez-faire approach and say, "Well, we have to support good things that happen whatever they might be."

So if you look at my experience in oil sands, AOSTRA was very targeted; it was a time-limited push in a particular area that made some tremendous strides, but it didn't take the University of Alberta or the University of Calgary to the state where we are now in terms of capability and partnership. That actually took, in our case, the programs with the federal government, which were enabling -- the federal government at the time never identified oil sands as a priority for anything. In fact, they were steering some of their programs away from oil sands. But they had an enabling program for university/industry partnerships that we grabbed onto and built on. And anybody who could build a partnership could come in and make an application. So it was, it was very neutral, very enabling. They were trying to achieve certain things across the entire range of science and engineering and, and so it was enabling strategy.

So the challenge, the same challenges for universities, if you're going to hire people and try and build up particular areas, how do you pick the winners 10 years, 20 years in the future? You do the best you can but you have to recognize you're going to get leaders and exceptional people popping up wherever, wherever they will, where you may not expect them. How do you set the stage for that

excellence and how do you enable it? For governments, how do you avoid piling on a bandwagon that collapses and then you are left holding the bag? You mentioned IT.

AD: Yeah.

GRAY: That happened across North America. Governments piled on; they all wanted to be IT leaders; they didn't want to miss the boat. They hired all sorts of people, recruited students, and then everything collapsed. So how do you avoid that where you're trying to pick a winner and you're trying to get ahead of everybody else in the same field when, in fact your chances of totally blowing it are very high. Instead of saying well, how do we have a much broader approach where we try and how do you encourage economic diversification without picking what the areas of diversification are going to be?

I don't know the answer to that, but what I've seen is where you try and pick a select few of things that you think are going to be winners 10 and 20 years out, it usually doesn't work. It's unlikely to succeed.

AD: But what we've seen through, from AOSTRA onward, you know, the NSERC area -- era -- is that you need to have this kind of pure research that then -- and the strong relationships with industry that …

GRAY: Yes.

AD: … then creates a vehicle for its application.

GRAY: Yes. You need, you need sustained effort.

AD: Yes.

GRAY: It can't just have peaks and valleys. There's no point saying next year we're going to spend 20 million dollars on a big push and after three years it's totally gone and there's nothing left.

AD: Yeah.

GRAY: That will not build …

AD: Yeah.

GRAY: … excellence of any sort. You need the sustained push. AOSTRA was a fairly sustained push of significant activity over a space of about 15 years.

AD: Exactly.

GRAY: And that was enough to generate a whole generation of highly trained people that then moved into the industry. If it had been a much shorter push, it wouldn't have had …

AD: Yeah.

GRAY: … that kind of benefit.

AD: Well, you see, with myself doing the majority of the interviews [in the research area], my colleague in Calgary certainly is interviewing people at the U of C that you [know]-- I don't know whether anybody has ever stated so clearly that AOSTRA, of course, has this set of achievements and now there's talk in government of AOSTRA Two.

GRAY: Yes.

AD: But in fact we've seen the federal government and of course we know that … Canmet, of course, is a beneficiary of the federal government's wanting to appease the Government of Alberta for loss of royalty revenue, so yeah, you pile this money in to research …

GRAY: Mmhm, yes.

AD: … and you create Canmet Energy. I mean, so the research establishments, as in the Karl Clark era, are absolutely essential.

GRAY: Absolutely, and they have to be sustained support.

AD: Exactly. So I think that's …

GRAY: Yes.

AD: … a nice bit of closure, isn't it?

GRAY: I think so.

AD: Okay, thanks so much.

GRAY: My pleasure.

[THE INTERVIEW CONCLUDES.]