



COMMISSION OF INQUIRY RESPECTING THE MUSKRAT FALLS PROJECT

Transcript | Phase 1

Volume 1

Commissioner: Honourable Justice Richard LeBlanc

Monday

17 September 2018

CLERK (Mulrooney): This Commission of Inquiry is now open.

The Honourable Justice Richard LeBlanc presiding as Commissioner.

Please be seated.

THE COMMISSIONER: Good morning.

Today we begin the public hearings of the Commission of Inquiry respecting the Muskrat Falls Project. I welcome those present here in the Lawrence O'Brien centre, as well as those joining us via webcast.

My name is Richard LeBlanc, and I am a Justice of the Supreme Court of Newfoundland and Labrador and the Commissioner for this Inquiry. Let me, first of all, thank everyone here in Happy Valley-Goose Bay and elsewhere who has assisted us in any manner to begin the Commission hearings here in Labrador.

I recognize that the Muskrat Falls Project has and will have a significant impact to all of the province, but in particular to the residents of Labrador, Indigenous and non-Indigenous, as much of the physical infrastructure for the project is constructed and situate on the Churchill River.

While most of the hearings of the Inquiry must be held in St. John's due to space requirements, practicality and cost considerations, this Commission has scheduled further hearing dates here in Happy Valley-Goose Bay in recognition of the link between the project and Labrador.

The last nine months or so have been extremely challenging for the staff of the Commission in order to prepare for these hearings. We have received over 2½ million documents that have had to be dealt with. I must acknowledge the efforts of those who provided documents, in particular, the Government of Newfoundland and Labrador and Nalcor, from whom the vast majority of documents emanated.

We have been actively reviewing what we have categorized as potentially relevant documents in preparing for these hearings. Numerous witnesses have been interviewed and experts have been engaged, where necessary. I could

never thank the staff of the Commission enough for their dedication and countless hours of work, including evenings and during very warm weekends this summer, to assist in the investigation conducted.

Led by Kate O'Brien and Barry Learmonth, Commission counsel, as well as our team of three associate lawyers, six researchers, two IM staff, a CAO, operations manager, an able administrative assistant and a summer student, significant work has been done to prepare for these public hearings. The workload and output by the staff has been gargantuan from my perspective. I wish to publicly express my sincere appreciation to all of them for their past and continuing service to this Commission of Inquiry. I am very lucky to have them.

I am satisfied as of now that we have used the limited time that we have had to investigate the project as best as is possible, considering the magnitude and complexity of what it is we have been given as a mandate to do. I can say that the work of this Commission of Inquiry has been framed by the terms of reference established in this Inquiry, as well as my interpretation decision of those terms on March 14, 2018.

Full standing has been granted to 10 parties, while 11 others have been granted limited or special standing as regards the Inquiry hearings. While those parties granted full standing may participate in all aspects of the Inquiry hearings, limited and special-standing parties will participate only to the extent of their interests as determined by the basis upon which each has been granted standing.

In making my opening remarks this morning, I am keenly aware that they must be shorter than what I would have liked, based upon the importance of giving as much time to our first witness to be called as is possible. This, too, means that I will only be able to call upon Commission counsel to speak to the plans and schedule for this Inquiry after we complete the evidence of the first witness.

However, it is important that I reiterate some of what I stated on April 6, 2018 at the standing hearings. First of all, it is important to describe what a public inquiry is and what it is not. A public inquiry is generally established to

investigate and report on a matter of substantial public interest. Here the sanction and construction of the Muskrat Falls Project is generally what will be looked at, particularly as regards to the involvement and actions of the Government of Newfoundland and Labrador, and of Nalcor.

What this public inquiry is not, is that it is not a trial as that term is generally understood. No one is charged with a criminal offence, and nor is anyone being sued. I am not permitted to express any conclusion or recommendation regarding the civil or criminal responsibility of any person or organization as part of my findings or in any recommendation that I might make.

Here I see the Commission's purpose as being to permit the relevant parties and people involved to set out the story as regards the Muskrat Falls Project, from its conception to its expected completion and operation, based upon the mandate given to us.

The Commission of Inquiry and the public must be given the opportunity to hear what has transpired and so, as to be able to assess this. I will be ensuring that the witnesses called are given a fair opportunity to provide the relevant information they have. Counsel to this Inquiry are well aware of my desire in that regard.

I do recognize that we have an aggressive and robust schedule for these hearings. This is necessary again due to the complexity and extent of the issues we must deal with. The number of witnesses that are needed as well as the limited time that we have to conclude all the phases of the Inquiry basically mean that its schedule is paramount.

This means that all counsel present and the parties they represent must be cognizant of the need to move along in the most efficient yet thorough manner possible. I intend to keep us all on track as regards the schedule we have. While I'm quite aware that some of the public want me to extend the terms of reference or the mandate of this Inquiry, I'm not able or willing to do that. Participation by the parties given standing is restricted to the terms of reference as interpreted by me on March 14, 2018, as well as the basis upon which each of the parties has been granted standing.

I also fully recognize the importance of transparency and openness in these hearings; however, now it seems clear to me that I may be receiving some evidence that I must not make fully public. This is not being done to hide anything. I'm bound by certain legal privileges that require that some evidence not be presented. For instance, evidence subject to solicitor-client privilege cannot be led unless the privilege is waived by the applicable parties.

The issue of water management on the Churchill River is a matter that I will be considering. There is ongoing litigation between Nalcor and Hydro-Québec currently in the Quebec courts, possibly impacting the management of the flow of the water along the Churchill River. While I've already indicated that I will be looking at what consideration was given to water management at the time of sanction, I do not want to do or say anything that could negatively impact the interest of the province and the position taken by Nalcor in that case. That would not be in the public interest.

Therefore, some of the evidence that I hear and consider regarding this issue may not be able to be made public, notwithstanding that I will be considering it in making my findings and recommendations.

As well, particularly for Phase 2 of the Inquiry regarding cost overruns and oversight, with a project of this magnitude and with construction continuing, it can be expected that certain of the issues we will deal with maybe subject to further court or legal processes. As a result, and to ensure that the parties and the public are protected as much as is possible from further negative legal and/or financial consequences, there may well be some evidence that cannot be fully accessible to the public or all of the parties, although again, such will still be part of my consideration in making findings and recommendations at the conclusion of the hearings.

For such evidence, I have instructed Commission counsel to ensure that they should presume that the evidence is to be led in public, and it is only where they are satisfied that it would not be in the public interest or unfairly damaging to a party should they seek to have this evidence heard without full public scrutiny.

I wish here to be clear that merely because the evidence in question may cause embarrassment, a loss of confidence or amount to serious misbehaviour, such is not a basis for the evidence to be withheld from public scrutiny at these hearings.

In any event, where it is decided that evidence will not be presented for public viewing, I am hopeful that some notice of what that evidence generally entails will be made accessible to the public where possible. Having said this, I want to make it clear that the vast majority of the evidence to be presented at this Inquiry will be available to the public.

The focus of these hearings, being phase 1, is on the sanction decision for this project, as well as the review of the involvement of the Public Utilities Board. This phase will take us up to the Christmas break. Commencing in late February 2019, as indicated above, the Commission's focus will turn to the construction of the project, the resultant cost escalation and oversight of construction and costs by Nalcor and the government. That phase, phase 2, will take us to mid-May and will be followed by a final phase, phase 3, dealing with future policy and systemic reasons – systemic matters, rather.

Finally, there has been much publicity and discussion about this project to date. Now the opportunity is here to hear about the significant details of the story of the Muskrat Falls Project. We at the Commission are determined to present the facts in a manner as fair as is possible to all parties in order for there to be, ultimately, a fair and appropriate consideration of the evidence.

With all of this in mind, I will now be shortly calling upon Commission co-counsel to call their first witness. Before I do that, I would ask each of the counsel appearing this morning, starting from my very right, to stand, identify themselves and quickly identify who it is they're representing.

MR. RALPH: Good morning, Mr. Commissioner.

Peter Ralph and Nick Leamon representing Her Majesty in Right of Newfoundland and Labrador.

MR. FITZGERALD: Good morning, Commissioner.

Andrew Fitzgerald for Julia Mullaley and Charles Bown.

THE COMMISSIONER: Okay. Just a reminder just to make sure your mic on your table is on when you're standing.

MR. SIMMONS: Good morning, Commissioner.

Dan Simmons and with me Dana Martin representing Nalcor Energy.

MR. BUDDEN: Good morning, Commissioner.

Geoff Budden representing the Concerned Citizens Coalition.

MS. URQUHART: Good morning, Justice.

Caitlin Urquhart representing the Labrador Land Protectors and Grand Riverkeeper Labrador.

MR. SMITH: Harold Smith, I'm representing Mr. Ed Martin.

MR. GRIFFIN: Good morning, Commissioner.

Steve Griffin for the former Nalcor board.

MR. T. WILLIAMS: Good morning, Commissioner.

Tom Williams for former government officials.

MS. BEST: Good morning, Justice.

Erin Best representing Kathy Dunderdale.

MR. PEDDIGREW: Good morning, Commissioner.

Christopher Peddigrew on behalf of the Consumer Advocate for the province and the 300,000 ratepayers of the province.

MR. LUK: Good morning, Commissioner.

My name is Senwung Luk on behalf of the Innu Nation.

MR. GILLETTE: Good morning, Commissioner.

Mark Gillette on behalf of Nunatsiavut Government.

MS. VAN IDERSTINE: Good morning, Commissioner.

My name is Helga Van Iderstine. I'm here on behalf of Manitoba Hydro International.

MR. COOKE: Good morning, Commissioner.

Jason Cooke here on behalf of NunatuKavut Community Council.

THE COMMISSIONER: Right, welcome all.

All right, I'll call upon Kate O'Brien first of all.

MS. O'BRIEN: Good morning, Commissioner.

Before we begin our proceedings today with the first witness, I'm gonna ask to enter three exhibits. These exhibits are the terms of reference for this Commission, the rules of procedure that have been developed for conducting this Inquiry and, finally, a timeline that was prepared by Commission associate counsel with input from counsel from all the parties.

It is hoped that this timeline will assist us as we go forward and hear the evidence. It is really a timeline of events leading up to the sanction decision of the Muskrat Falls Project.

So I ask that be entered exhibits P-00001, P-00002 and P-00005.

THE COMMISSIONER: All right. Any objection from any counsel here with regards to those? Each of you would've been provided with a copy of those.

All right, good. Those will be marked then as P-00001, P-00002 and P-00005.

MS. O'BRIEN: Thank you.

THE COMMISSIONER: Thank you.

Mr. Learmonth.

MR. LEARMONTH: Thank you, Commissioner.

Before calling the first witness, I would ask Madam Clerk to enter the following four exhibits into evidence: P-00003, which is a curriculum vitae of Professor Bent Flyvbjerg; P-00004, which is a report to the Commission of Inquiry Respecting the Muskrat Falls Project by Professor Bent Flyvbjerg dated August 2018; Exhibit P-00008 is a presentation for the Commission of Inquiry Respecting the Muskrat Falls Project by Bent Flyvbjerg. That's a slide presentation, which Dr. Flyvbjerg will be going through, based on the contents of the report; next, P-00010 is an agreement dated May 10, 2018 between Professor Flyvbjerg and the Commission of Inquiry; and last, P-00134 is an article of Professor Flyvbjerg entitled: "What You Should Know About Megaprojects and Why: An Overview."

Now, Madam Clerk, would you please arrange to have those four exhibits entered into the record.

THE COMMISSIONER: All right.

Is there any objection to any of those exhibits at this stage being entered? All right, no. So those exhibits then will be entered as indicated and marked.

If you want to call your first witness then, Mr. Learmonth.

MR. LEARMONTH: The first witness I will call is Professor Bent Flyvbjerg. Could Dr. Flyvbjerg – or Professor Flyvbjerg, please –

THE COMMISSIONER: No, Sir, if you could just walk – come right up here and remain standing when you get to the desk.

CLERK: Could you take the Bible in your right hand please?

Do you swear that the evidence you shall give to this Inquiry shall be the truth, the whole truth and nothing but the truth so help you God?

DR. FLYVBJERG: I do.

CLERK: Please state your full name for the record.

DR. FLYVBJERG: Bent Flyvbjerg.

THE COMMISSIONER: You'll have to pardon our pronunciation of your last name, but anyway, we know who you are, and I guess we'll get to know you as you testify. You can be seated there sir, and –

DR. FLYVBJERG: Thank you.

THE COMMISSIONER: Mr. Learmonth.

MR. LEARMONTH: Professor – may I call you Professor Flyvbjerg – I – is that acceptable?

DR. FLYVBJERG: It's acceptable, yeah.

MR. LEARMONTH: Thank you very much.

Well, first I'd like to welcome you to Labrador, and we are all very pleased to have you here with us today to give your evidence.

DR. FLYVBJERG: Thank you.

MR. LEARMONTH: Yeah.

Professor Flyvbjerg, will you please confirm that you are the BT professor and inaugural chair of Major Programme Management at Oxford University's Said Business School, is that correct?

DR. FLYVBJERG: I am.

MR. LEARMONTH: And in addition, is it correct that you are a professorial fellow of St. Anne's College in Oxford, England?

DR. FLYVBJERG: Correct.

MR. LEARMONTH: I have that right, do I?

DR. FLYVBJERG: Yes.

MR. LEARMONTH: Okay.

Now, I'd like you to please refer to your curriculum vitae, which has been entered as Exhibit P-00003. I want to take you through some of the main parts of your curriculum vitae.

Your curriculum vitae says in paragraph 3, page 1, that you serve as an "advisor and consultant to government and business, including the US and UK governments and several Fortune 500 companies." Is that correct?

DR. FLYVBJERG: Right.

MR. LEARMONTH: Yeah. Are there any other countries, sovereign states that you have advised on megaprojects?

DR. FLYVBJERG: Yeah, many others.

MR. LEARMONTH: Can you just give me a short list of those other countries?

DR. FLYVBJERG: Denmark, Sweden, the Netherlands, South Africa, China, several others.

MR. LEARMONTH: Yeah. And is your consulting business continuing on?

DR. FLYVBJERG: Yes, both my academic work and my consulting and advisory business is ongoing.

MR. LEARMONTH: Okay. So I take it you do a lot of travel to these foreign countries, do you?

DR. FLYVBJERG: Quite a bit.

MR. LEARMONTH: Yes.

In addition, paragraph 3, page 1, indicates that you're "an external advisor to McKinsey and other consultancies." How long have you been an external advisor of McKinsey?

DR. FLYVBJERG: Ten-plus years.

MR. LEARMONTH: Okay, and you still are?

DR. FLYVBJERG: Yes.

MR. LEARMONTH: Okay.

Your curriculum vitae indicates that you – you're research has been covered by a number of publications including: *The Economist*, *Financial Times*, *Wall Street Journal*, *New York Times*, *China Daily*, *BBC*, *CNN* and other media outlets. Is that a correct statement of your

– the coverage that you’ve received in these various publications?

DR. FLYVBJERG: That is correct, yes.

MR. LEARMONTH: Okay.

And in terms of your education, can you run through, while referring to your CV, your educational background since you finished high school.

DR. FLYVBJERG: I went to Aarhus University in Denmark and I got my masters degree – bachelors and master’s degree there in economic geography and I did my Ph.D. there in economic geography also. And as part of my Ph.D. at Aarhus University, I did course work at the University of California at Los Angeles as part of my doctoral work. And after that I’ve done two higher doctorates, so on top of the Ph.D. – in Denmark where I’m from, we have something called higher doctorate, as does Germany and other countries, and I have one of those in engineering and one in science.

MR. LEARMONTH: And it’s stated in your CV that you have “received numerous honours and awards, including” – the – “Harvard Business Review’s ‘Idea Watch’ for the most important new idea to follow and the Project Management Institute’s and Project Management Journal’s” Is that correct?

DR. FLYVBJERG: Yes.

MR. LEARMONTH: Yeah. And I note, also, that you’re – you received a knighthood in –

DR. FLYVBJERG: Correct.

MR. LEARMONTH: – the United Kingdom in 2002?

DR. FLYVBJERG: Not in the United Kingdom – in Denmark –

MR. LEARMONTH: In Denmark, all right –

DR. FLYVBJERG: – where I’m from.

MR. LEARMONTH: – sorry. So you’re entitled to use the name “Sir”?

DR. FLYVBJERG: We don’t do that in Denmark.

MR. LEARMONTH: Oh, you don’t? Okay.

DR. FLYVBJERG: You’re just a knight.

MR. LEARMONTH: Okay, I’ll stick with professor then, I guess.

DR. FLYVBJERG: Okay.

MR. LEARMONTH: Yeah.

The – please confirm that in carrying out your work for this Commission of Inquiry, you have not been provided by Commission counsel, or anyone else in the Commission, with any details or particulars about the Muskrat Falls Project. Is that correct?

DR. FLYVBJERG: That is correct.

MR. LEARMONTH: Yeah.

And so you’re evidence – your report applies to megaprojects in general, as opposed to the Muskrat Falls Project specifically. Is that correct?

DR. FLYVBJERG: Correct.

MR. LEARMONTH: Yeah.

Could you provide us with your definition of a megaproject?

DR. FLYVBJERG: As a rule of thumb, we define a megaproject as something that costs more than a billion dollars. That’s the short definition.

MR. LEARMONTH: All right. Well, the Muskrat Falls Project certainly qualifies for – under that definition.

Commissioner, I propose to have Dr. – Professor Flyvbjerg qualified, generally, as an expert in megaproject management and research methodology, and specifically, as an expert to provide opinion evidence on three specific topics which are stated on page 2 of the report that has been entered into evidence as Exhibit P-00004.

THE COMMISSIONER: Could you just briefly identify what –

MR. LEARMONTH: Yeah.

THE COMMISSIONER: – those are?

MR. LEARMONTH: Yeah. The – so unless any counsel has any objection, I request that Dr. Flyvbjerg be so qualified as an expert and to provide opinionnaires in those topics. If any counsel has an objection, (inaudible) counsel, please rise and state –

THE COMMISSIONER: Just before we do that, Mr. Learmonth, what are the three specific areas that you wanted the expertise to be recognized in?

MR. LEARMONTH: Well, in megaproject management, megaproject research methodologies and on the three topics that are identified on page – in the report, namely: What is the national and international context of the Muskrat Falls Project with regards to cost overruns and schedule overruns? “What are the typical cost and schedule overruns of hydro-electric dam projects?” How do hydroelectric dam projects compare to other capital investment projects? “How do Canadian projects compare to other countries?” That’s the first topic.

The second: “What are the causes and root causes of cost and schedule overruns?” And the third topic: “What are recommendations, based on international experience and research into capital investment projects, to prevent cost and schedule overruns in hydro-electric dam projects and other capital investment projects?”

Those are the three areas for which I seek to have Professor Flyvbjerg qualified to express opinion evidence.

THE COMMISSIONER: All right.

So does any counsel wish to ask any questions of Dr. Flyvbjerg before I consider allowing him to express opinion evidence here today?

Can I just – just before we do that, Professor Flyvbjerg, I note that you have published or have been involved in publication of numerous

documents. You have also been involved in the production of some texts with regards to megaprojects. So obviously, you have an interest in megaprojects and megaproject management costs, et cetera.

Can you talk a little bit about how you, sort of, obtained that interest and exactly how expert do you think you are?

DR. FLYVBJERG: Well, I got my interest in megaprojects when they first came to Denmark. There was a huge tunnel, the second longest underwater tunnel in Europe and the longest suspension bridge, at the time of completion, in the world was constructed, and they both went terribly wrong. And I just, you know, as a scholar, curiosity is what drives you.

So I got curious. Were we just very unlucky in Denmark or were we dumb? What’s going on here? So I was asking the question: Is this a typical thing or is this an unusual thing to have big multi-billion dollar projects like this go wrong? And then I did the search of this in libraries and, you know, publications and I found there was very little written on this, which I found strange because it’s a lot of money that are going into these projects and there was very little research. So I figured there was a job to be done here, you know, to find out – to answer that question, basically, is this normal or not. And that’s how it started out. That was our first study in this area and that’s 20-plus years ago.

And it’s not something I do alone. I’ve had teams all along, in Denmark and now at Oxford, and I also worked in – at the Delft University of Technology in the Netherlands and had a team there. So it’s not just me, it’s a whole group of colleagues and myself who are doing this. And we’ve been at it for a couple of decades now and we’ve developed a large body of knowledge in the area. And we’ve been first movers, so we’ve been ahead of other people who have come in later. So now it’s a big research area. It didn’t used to be.

And, like, Oxford decided to make a whole program. There’s both an educational program that’s a degree program at Oxford University in this area now and – or so a big and well-funded research area. In the beginning it was the research centre, now Oxford University decided

to make it a permanent academic area on par with mathematics and physics and literature studies, et cetera.

So it's an area that has developed very quickly. And I would say since we started early we had a head start and we've tried our best to keep it. I don't think it's up to me, you know, to decide how big of an expert I am and compared to others and so on. That wouldn't be appropriate. But on some objective measures like, you know, in academia we measure these things by how much that you size it, and there are independent biometric studies. And you don't have to believe me on this, they are out there and they're published, documenting that are more cited than anybody else in this area.

THE COMMISSIONER: Okay. And you're familiar with all of that.

DR. FLYVBJERG: Yeah.

THE COMMISSIONER: Yeah.

Okay, any questions as a result of that one?

All right, then in the circumstances I will allow Dr. Flyvbjerg to provide evidence – provide opinion evidence with regards to megaprojects, megaproject methodology, costing, issues involving causes and root causes of project overruns, recommendations, all those things that are set out in his report.

So, you can proceed, Mr. Learmonth:

MR. LEARMONTH: Thank you, Commissioner.

Professor Flyvbjerg, would you please look at Exhibit P-00004, which will be shown on the screen and it's also in a hard copy in front of you. Have you found that, Professor Flyvbjerg?

DR. FLYVBJERG: P-00004?

Yup, found it.

MR. LEARMONTH: Okay.

Are you satisfied that the contents of Exhibit 00004, your report, be accepted as your evidence under oath at this Inquiry?

DR. FLYVBJERG: Yes.

MR. LEARMONTH: Yeah. You prepared this yourself and reviewed it and accept responsibility for its accuracy. Is that correct?

DR. FLYVBJERG: Yes.

MR. LEARMONTH: Okay.

Now, you've also prepared for us a slide presentation, which I understand is based on your report? That slide presentation is Exhibit P-00006, if that could be brought up. And I understand that the purpose of this slide presentation is to provide an easy-to-follow illustration of the main points that are contained in your report. Am I correct?

DR. FLYVBJERG: Yes.

MR. LEARMONTH: Okay.

Now, Commissioner, the procedure that I have discussed with Professor Flyvbjerg, and which I propose to follow here today, is that Professor Flyvbjerg will take us through the slide presentation, and after that I will have some follow-up questions.

After I've completed my questions, I will ask counsel if they have any questions. After those questions have been completed, there may be some further questions that you may have, Commissioner, and that will be the order that we propose.

Is that procedure acceptable –

THE COMMISSIONER: It's fine.

MR. LEARMONTH: – to the Commission?

THE COMMISSIONER: It's fine.

MR. LEARMONTH: Okay.

I will now ask you, Professor Flyvbjerg, to take us through your slide presentation. I believe you have the clicker there, and you can take us through at the pace that you feel is reasonable in order to get your message across.

DR. FLYVBJERG: Thank you very much.

And as you said, this is a summary of main points in the report that I prepared for this hearing. And like you also mentioned, there are three main issues that we are covering here. One is what is the national and international context of the Muskrat Falls Project with regards to cost overrun and schedule overrun specifically? So, basically, the question here is: What does cost overrun and schedule overrun look like internationally?

Second, what are the causes and root causes of what we see in the numbers? Like, why do things look the way they do regarding cost overrun and schedule overrun? What are the explanations? That's the second point. The third point is what can we do about this? What recommendations can we develop in order to make sure we don't have cost overruns and we don't have schedule overruns?

So those are the three main points. And we just take them one by one, one point at a time. So let me start with the first one, the national and international context here. The data that we're doing this on are from a sample of 274 hydroelectric dam projects around the world. And by the way, this is the largest academic data set that exists in the world, so nobody has more data or better data than what we have used for preparing the report for this Inquiry.

And the projects are in 75 different countries around the world on six continents and they're built from 1936 to 2015. We're actually interested in older projects because we want to see where the people learned over time, so we need older projects in order to see whether the new projects are better or not than the older projects. So that's one of the reasons that we go back in time too.

Just to specify how cost overrun is measured, there are two different ways of doing that: one is a ratio and the other is percentage. So if you look at this formula $O = \frac{CA}{CE}$ – the first one, number one, O equals CA divided by CE . C is cost and then CA is actual cost and CE is estimated cost.

So let's assume you have a project that turned out to – it cost \$4 billion, but in the original business case it was estimated that at \$2 billion, then you'd have four divided by two is the overrun, right? Four divided by two, that's two

so that's the ratio. There's a ratio of two. If you did the second formula, which is the same thing, you just do it as a percentage as all of us learned in school, then we'd know this is 100 per cent cost overrun, like it'd be four divided by two, two minus one times 100. That's 100 per cent overrun. So very simple that's just to explain how the numbers that you're going to see now have been calculated specifically.

There are two things to note here that are really important and that is what is the baseline that you're measuring from historically, so where do you start? And here in the numbers that I show you we are measuring from the date of decision, also sometimes called the final investment decision or the sanctioning of a project. So this is the formal decision to actually go ahead with the project. That's our baseline. And then we measure whatever costs – additional cost that has accrued from that date on top of the estimates and that's the overrun.

If you wanted to measure contractor's performance you wouldn't use this baseline, you'd use a different baseline. Then you would choose the contractor's estimate in the tender process and then you'd baseline from there. That would typically be several years later in a project like this than the baseline that we are using here, and the results depend on the baseline. That's why I'm pointing out this as an important thing in this.

The second important thing is that the numbers I'm going to show you are measured in constant prices, so no inflation is included. There are two different ways of doing this. You can include inflation or you can exclude inflation. We prefer to exclude inflation because we think it gives a more clear picture of what actually happened on the project. But if you did include inflation, the numbers would be much higher. So you need to keep that in mind when you see the numbers.

Anyways, those are the ways that we measure cost overrun. So here are some numbers where we use this way of measuring cost overrun. So these are cost and schedule overruns in hydroelectric dam projects all around the world – so the whole sample of 274 projects – what do we find?

So as you can see in this still, we find an average cost overrun of 96 per cent for hydroelectric dam projects around the world. The median is 32 per cent. Interesting, there's huge variation as you can see, so all the way from minus 47 – that's the lowest cost overrun and that's actually a cost underrun. A minus overrun is an underrun. So it came in 47 per cent cheaper than estimated, this particular project, and there's one that had 5,142 per cent cost overrun, so you can see it's an enormous variation.

So this is what you expect when you're producing something like a hydroelectric dam. Obviously, Toyota, when they're producing cars, they would never expect variation like this. You wouldn't have one car would cost 5,000 per cent more than another car or what was estimated, and another car costing half of what was estimated. So we're talking about a product here that is very non-standard and therefore has enormous variation in cost overruns. That's an interesting and important result that the data shows that you need to be aware when you're doing these things.

For schedule overrun, we find – so how much did the project go over time? There's a 42 per cent schedule overrun, so less than half the cost overrun. The median is 27 per cent, almost the same as the median for cost overrun. So the difference between average and median is not as big for schedule as it is for cost. As you can see, the variation is also not as big, but still very big, so from minus 29 per cent to 402.

The frequency of cost overrun is higher for both of them, so it's actually eight out of 10 projects have cost overrun and schedule overrun. So you are much more likely than not to experience this phenomenon of cost overrun and schedule overrun if you do something like building a hydroelectric dam. So that's what the numbers show for the whole sample of hydroelectric dam projects.

There's one thing that we are particularly interested in, and that people are particularly interested in, regarding these projects. Because we had this big variation here – oops, let's go back again. Because we had this big variation, we want to understand how many projects actually have very high cost overruns, what we call outliers. So we calculate the outlier.

So an outlier is just a very large value. Statisticians talk about outliers, and it's just an extreme value. So we are now looking for extreme values. They are sometimes also called black swans. Maybe you've heard this term, black swan. Black swans are extreme events, unexpected extreme events with huge impacts.

So if we define outliers in the standard statistician's way, which is – it's technical, so we don't need to get into that. But when we use that, we find that the cost outliers are – in a cost overrun that is larger than or equal to 207 per cent, that would be called an outlier, and by some people it would be called a black swan event in hydroelectric dam construction.

And we see that 10 per cent of all dams are actually outliers in this end. So 10 per cent of all dams have 207 per cent or more cost overrun. So you have a one in 10 risk of having a cost overrun of 207 per cent or more when you do a hydroelectric dam. Actually, the average overrun of the outlier, so the average cost overrun of these 10 per cent of projects is 640 per cent. So you have a 10 per cent risk of 640 per cent cost overrun.

Doing the schedule, the definition of outliers is that it's a project with a schedule overrun that is 127 per cent or more, and we see that 6 per cent of all hydroelectric dams are outliers in this sense so have schedule overruns larger than or equal to 127 per cent. And the average for those 6 per cent is 195.

So that's what we call the fat tail, the upper tail so to speak. If you have a distribution of cost overruns, a distribution of schedule overruns, we look at the fat tail, like, the extreme values at one end of the distribution, and those are the ones that we see in this table.

And the table indicates that there is substantial fat-tail risk, there is a substantial risk for extreme cost overruns and extreme schedule overruns if you do something like a hydroelectric dam.

I talked about how things develop over time, and this is what these two diagrams show. So on the left-hand side here, you have cost overrun. Here it's measured as the ratio, so two is 100 per cent cost overrun; three is the 200 per cent cost

overrun. Here we have the date of the decision to actually build the dam all the way back from before the 1950s and all the way up to 2015, so up to the current situation.

And there's no improvement over time. So it's not like people have learned over all these decades to do this better, and actually nail it and get the hydroelectric dams on budget. And the same with time, as you can see. There's actually a slight increase, but we disregard that because it's not statistically significant. So we would say that what the data show is constant over time. There's no improvement in budget overruns – cost overruns; there's no improvement in schedule overruns.

So those were – all those numbers that I showed you until now is just about hydroelectric dams. Now we are going to be looking at comparing hydroelectric dams to other types of infrastructure. And first we look at a comparison with the transport infrastructure.

So now, we have the numbers that we just saw – they are all in this row here, the second row, called hydroelectric dams. So those are the numbers we just saw. If you look at road projects – so large road projects – we see that the cost overrun for road projects is 24 per cent. And it was 96 per cent for hydroelectric dams – so much lower for roads than for hydroelectric dams.

The stars here indicate how reliable are those numbers when we run statistical tests on them – so the more stars, the more reliable the numbers are. If there are no star, there's no statistically significant difference between the numbers. So only the numbers with stars are statistically, significantly different from hydroelectric dams. And that is – as you can see, roads and bridges with 32 per cent.

Tunnels and rail are lower – have lower cost overruns than hydroelectric dams. But the difference is not statistically significant. It doesn't mean that it doesn't exist, it's there; we can see it, but we just can't document by statistical analysis that there is a – what we could call a statistically significant difference.

If we look at schedule, we saw 42 per cent for hydroelectric dams, and it's 20 per cent for

roads. Again, that is significantly different. It's 23 per cent for bridges, 22 per cent for tunnels and 48 per cent for rail.

So over here all the other numbers were lower – all the cost overruns were lower than for hydroelectric dams, but here actually for rail projects there's a slightly larger schedule overrun for those than for dams. But again, this is not statistically, significantly different.

So basically the conclusion here regarding hydroelectric dams vis-à-vis transport infrastructure projects is that hydroelectric dams are more risky than transport infrastructure projects in terms of cost risk and schedule risk. That's what the data shows.

Now, let's look at energy projects. So now we're comparing dams with other energy projects. And, again, in the first row, or second row, actually, you have hydroelectric dams like before. But now we have wind power, solar power, thermal power, transmission lines and nuclear power, as the other types of energy infrastructure projects that we're comparing with. And as you can see wind power, solar power and thermal power and transmission lines are significantly lower than hydroelectric as regards to cost overruns. So they have lower cost overruns, all of them.

Solar power is one of the rare projects that's so far, with the data we have, it's pretty much on budget, which is rare for big projects. Nuclear power on the other hand has higher cost overruns than dams, and they're significantly higher. So statistically significantly higher. So, what you can say here again summing up is that nuclear has higher risk and is actually the only type of project we're looking at here.

Nuclear power projects are the only projects that have a higher cost risk than hydroelectric dams, and the same goes over here for the schedule overrun as you can see. Again, nuclear performs worse regarding schedule risk than do hydroelectric dams.

Finally, mining and oil and gas projects. Mining and oil and gas performs much better than hydroelectric dams; 17 per cent cost overrun on average compared to 96 per cent for dams, and

we don't have the data for schedule here so that's why there's only cost overrun here.

And then finally, let's look at – after having looked at hydroelectric dams per se and comparing hydroelectric dams to other types of infrastructure projects, now, let's look at Canada versus the rest of the world.

So, if we look at Canada compared to the rest of the world regarding hydroelectric projects, we see Canada has 41 per cent on average and the rest of the world is 99 per cent, so more than twice as high in the rest of the world; however, because of the huge variation in the projects, this is actually not statistically significant.

That doesn't mean that I would disregard it and say that Canada is not doing better. It definitely looks from the data that it is, but we would need more data. As you can see, we only have 19 projects from data, and when you have a small sample like that 19 projects, it's more difficult to document that it's actually a statically significant difference. My guess is that it's likely to be if we got more projects, if we could increase those 19.

The same with schedule, and there it is significant. So Canada has – actually has shorter schedule overruns on average for the 19 hydroelectric dams for which we have data, than the rest of world has for the 254 projects for which we have data. So for hydroelectric, I would say Canada performs better than the rest of the world.

Now, let's look at other types of projects than hydroelectric. So now we are looking at Canada versus the rest of the world for each of transport, energy, excluding hydroelectric, and mining and oil and gas. And as you can for transport, Canada is doing better regarding cost overrun and it's doing much better regarding schedule overrun, as you can see here for transport. For other energy projects than dams, it's doing slightly better than the rest of the world regarding cost overrun, and it's doing slightly worse regarding schedule overrun. But, again, neither of these two are significant, statistically.

Finally, mining, oil and gas. Canada is doing significantly better than the rest of the world with only 13 per cent cost overrun, as compared

to 44 per cent for projects in the rest of the world. And with schedule, we don't have available data, like I said before, so we can't make the comparison.

So, summing all this up, I will say that hydroelectric is more risky than most other projects, except nuclear. There's actually one other project type that is even more risky than both nuclear and hydroelectric, that's putting on the Olympics. And Canada actually holds the world record for overrun in the Olympics, the Montreal Olympics, but, hey, let's not get into that here.

So, yeah, hydroelectric is more risky than all other projects we compared with, except nuclear. And regarding comparison with the rest of the world, we find that Canada is performing – in most of the projects and categories that we looked at, Canada is performing better than the rest of the world. So very clearly in mining, for instance, mining and oil and gas extraction projects.

And that pretty much sums up the data. So that's the first part. How – what is the context of Muskrat Fall? So this is the context. The context is that building a hydroelectric dam is very risky. Only thing more risky is if you choose to build a nuclear power plant, basically, and that's the context.

It's not only in Canada, it's the whole world this is risky, and so both in terms of geography, in terms of project type and in terms of history. So it's also not only risky – it wasn't only risky in the past; it's risky today. So if you decide to build a hydroelectric power project today you have to face up to these are the numbers and these are the actual risks that you are incurring and it seems to be a very persistent phenomenon that has been with us for decades.

So that's summing it up for the first item.

Second item: causes and root causes. Here the question is: Okay, why does it look like this? Why is it that it's so risky? Why do we see these outcomes? Why do we see these large cost overruns? Why do we see these large schedule overruns?

The type of explanations we usually see here I've tried to exemplify by the Niagara Tunnel Project, which had a 62 per cent cost overrun and 43 per cent schedule overrun. And when they tried to explain what had happened they said that they – we had worse-than-expected ground conditions and we had more mixed-face mining than we thought we would have and there were additional tasks so we had to do profile restoration. And also, we had to allow additional time for removing the tunnel equipment before you could remove the coffer dam and actually start finalizing the thing.

So these are the types of explanations that we typically find. The thing about worse-than-expected ground condition is a classic, and scope changes is a classic that we find. And what I always say to organizations that come up with these explanations is that this is not an explanation, this is an excuse.

This is – what I would say here is that the problem is not that there were worse-than-expected ground conditions. We see that on pretty much every project. So if it's something that you have to expect, then it simply means that the people who planned this project were optimistic about the ground conditions.

So the question is: Did they have reason to be optimistic about the ground conditions or not? That's really the relevant question. And why are – were they optimistic about it? Why would you assume – why would it become – why would it come as a surprise that you had to remove the tunnelling equipment before you can get to work on the tunnel? That shouldn't be a surprise for anybody and, also, it shouldn't be a surprise for anybody that you need to do profile restoration. So what I would argue here is that the planners had been optimistic about all these things, so the real cause, the root cause of the cost overruns and the schedule overrun, is that optimism.

And we like to distinguish between causes and root causes. So here's an image, a popular image, of the root cause of risk. You know, people are optimistic about their abilities; this is something called overconfidence bias in the behavioural science literature – overconfidence bias. And this is what we see on a lot of projects that the kitten looks in the mirror and see a lion you know. We can do this and even though that

it's very difficult to build tunnels, which it is, and even though all other people, they have had problems with the underground condition, we are assuming that we are going to have less problems. And that's overconfidence bias and this happens on many, many things regarding scope, you know. All megaprojects have scope changes but, hey, let's assume that we'll have very few scope changes in our project. That's optimism and it's something that happens up front in the planning phase of the project.

And that's why we say to people your biggest risk is yourself. It's actually your optimism that's going to trip you up. It's not so much the object effect of the ground conditions or the weather or the scope changes – even though we, of course, fully acknowledge that these are real phenomena out there in the real world that you need to be able to deal with – but the real cause of the cost overruns and the schedule overruns is that planners were optimistic about all these things.

So the ground conditions and the scope changes and so on is really just a manifestation of the optimism. And it's almost like a law of physics. If you have been optimistic about the scope, it's going to come back as scope changes. If you had been optimistic about the ground condition, it's going to come back as additional work and problems in the ground. So that's really where you need to look and if you – also if you want to solve the problem, which we'll get to under the third point, you also need to solve it where it's actually generated. So you can't solve it by looking at just the surface manifestation of what's going on, you need to go back to the root and really solve it at the root, but we'll get to that.

And as you can see, this means that we are sort of changing perspective on this from risk being something that is external to a project, to something that is internal to a project. It's a complete change of perspective. And, again, I want to emphasize, it doesn't mean that we think that the objective external risks are not there, but they are not the main problem.

So take cost overrun for an example. Cost overrun is not even the problem, and as long as we try to solve the problem as cost overrun, we are never going to solve it. The problem is cost

underestimation. If you have cost underestimation, you will have cost overrun. There's no way around it. If you underestimate, your cost, it's going to come back as a boomerang as a cost overrun. So that's where you need to go. That's a change of perspective. So you need to start thinking about what is it in the estimation process that is going wrong, not what's happening several years later when your errors in the estimation process hits you during construction.

So there are three types of explanations. If you look at the academic literature, they have three types of explanation of this underestimation or this optimism that we are talking about now: One type is technical explanation, second type is psychological explanation and the third type is political-economic explanation. So let's look at them each in turn.

Technical explanations see the errors that we find in cost estimates as caused by bad data and bad models. And they will say if we get better data and better models we'd be able to solve this. This used to be the dominant explanation. Until 15, 20 years ago, until behavioural economics and behavioural science developed, and until behavioural economics won the Nobel Prize in economics in 2002, this was the dominant explanation. Now this has changed somewhat as we will see. But poor data and poor models was sort of the basic explanation until then. And, also, then of course the solution would be let's get better data and better models and we could solve this, you know, just by getting better data and better models.

And I want to emphasize that we believe very strongly in good data and good models; however, we can easily prove that that's not enough. It won't solve the problems, so we've tested whether this explanation actually holds up. If it really was just a problem of error and not having the right data and the right models and making errors when you were forecasting, you would expect the distribution of errors to be more or less symmetrical around zero.

I mean that's the definition of an error is that you – sometimes you would overestimate the cost; sometimes you would underestimate the cost if it was really an error, and the same with schedule. And you would expect a pretty much

symmetrical distribution around zero and we can easily test for that, and as you can see on these numbers, those of you who understand statistics, we find with enormously high statistical significance that this is false.

These are not errors. The distribution is hugely biased and is not centred around zero. So the cost overruns are positive. The schedule overruns are positive and they are significantly different from zero. And, also, there's this fat upper tail on the distribution that I talked about before, a thick upper tail. So the first type of explanation, the technical explanations do not hold up.

That brings us to the second type of explanation. Those are the – if we go back you'll see those were the psychological explanations, right? So that's the second type. That's the type of explanation we get to now. So psychology – what does psychology say about this? Well, psychology says that these errors are created by cognitive biases. And with this slide I just want to illustrate to you that we all have cognitive biases.

If you look at slide – at square A and B, so the square with an A in it and the square with the B in it and I ask you: What colours do you see there? The vast majority of people – close – very close to 100 per cent will say black and white. So the square with A in it is black and the square with B in it is white. Some will say the square with A in it is like a dark grey and the square with B in it is a light grey – very light grey. And very few people will say like one is blue and the other is red; I actually haven't come across that. So close to 100 per cent would say what I just referred.

And the truth is that these two squares are the same colour. I didn't believe that when I first saw this slide. I didn't believe it. I had to go home and print it out and cut out the A and B square, then put them next to each other to actually confirm – you know, you're very rigorous at Oxford so that's how we do things. We get out the scissors and test like that, and I encourage you to do the same thing. It's pretty mind-boggling when you do that and you realize that these two squares are actually the same colour and it's all being produced in your heads by cognitive biases that they look different.

First of all, there's a shadow cast by the green object, right? There's a shadow cast on the checkerboard. Plus, we have seen checkerboards so many times that our brains automatically assume that this is black and white, you know, so they're all sorts of thing that the brain does. The brain is very good at this, probably for survival reasons, that we don't need a lot of information in order to make a lot of assumptions and then just get up with the result. Yeah, it usually works.

Sometimes those results are very wrong and that's what the psychological explanations focus on are these cognitive biases and how they trip us up in decision making. So this is just a – this is a visual cognitive bias, right? The bias that I want to talk about here is what we call optimism bias. So I talked about optimism earlier, that you are – you might be optimistic about the geological conditions. You might be optimistic about scope and you can see if we have similar biases regarding estimating the cost or estimating the schedule of that huge hydroelectric dam or whatever megaproject it is that we're building that can really trip us up.

And that's actually what has been documented by the behavioural physiologists and behavioural economists is that that's exactly what happens. That human beings are hard-wired to be optimistic about any plan that we make. That's how we are. Probably for good reasons, you know, to get up in the morning and get on with what we're doing, we need optimism. And I'm not sitting here saying that optimism is a bad thing, I'm just saying if you're a good leader you know when it's good and you know when it's bad for you.

And in estimations, it's often bad for you. So I – when I was flying up here last night from St. John's, if I'd heard the pilot say I'm optimistic about the fuel situation, I probably wouldn't have wanted to get on that plane, you know. A pilot that is optimistic about the fuel situation doesn't sound like a real pilot to me. You know, you want the pilot to be certain about the fuel situation. You might want, you know, the cabin attendant to be an optimist, to give a good flight but you definitely don't want to be optimistic about the fuel situation.

So in flights, you know, this is one – actually if you want to study an area where they had really stamped out optimism and all the cognitive biases because it's just – it's too – I mean, the consequences are too dire in the – you know, in the aerospace industry if you allow these biases to prevail. So they've done lots of stuff to get rid of them and that's basically what you need to do in megaproject planning and management also.

But anyways, the psychological explanations explain in terms of these cognitive biases. And two important points here is that even if you know the – that you are biased, you're still biased. As you can see, I've told you now that A and B are the same colour. You don't see them as the same colour, so your brain is still doing the trick on you even you know – even though that you know that you're biased now.

And second, something that is often overlooked in megaproject planning and management, is that experts are just as biased as laypeople. So people think that if they get a group of risk experts into a room to assess the risks and do the usual, you know, filling out of the questionnaires of how much risk do we have here, they think they have an objective assessment of risk. It's false because the experts are just as biased as laypeople. So what you have is a biased assessment of your risks, and that happens on the majority of megaprojects that I've studied – that happens, that you get subjective risk assessments that are optimistic.

And that comes back, like I said before, as a boomerang. If you have been optimistic, realism will hit you. There's no way to avoid it. It really is like a law of physics in what we see.

Optimism bias is defined as the demonstrated systematic tendency for people to be overly optimistic about the outcome of planned actions. Like I said before, it applies to anything you plan. So this is not just about megaprojects, or hydroelectric dams, or nuclear power plants, this is about anything we do. When we plan things we are optimistic about it, so we overestimate the likelihood of positive events and we underestimate the likelihood of negative events.

And I'm sure you can see how this will influence managers and planners' decisions. So, if this is true, then management would

underestimate cost, completion times and the risks of planned decisions. And they would overestimate the benefits of the same decisions. And this underestimation of cost, et cetera, and overestimation of benefits is what's called the planning fallacy. And this is exactly what we see in the data. So this explanation perfectly fits the data.

So, the psychological explanation as opposed to the technical explanation is the psychological explanation actually fit the data. When we run the test, we get a very strong indication that this is a theory that fits the data.

We know – we also know what is causing this optimism. It is that human beings tend to understand their plans from the inside out. So if you look at conventional cost engineering, it's very much about breaking a project down in its constituent parts, and then decide what do the individual parts cost, and then multiplying quantity with price and adding it all up again. That's the typical example of using the inside – you understanding a project from the inside out.

The cure is something called the outside view, where you look at what did similar other projects cost or how long did they take. And then you assume that your project is going to be something – take about as long as that and cost about as much as the other projects that are similar. We'll get back to that.

However, there's a third type of explanation. So far we've covered technical explanations and psychological explanations. There's a third type: the political-economic explanations. And, as opposed to optimism, they are not non-reflected. So optimism is innocent in the sense that the people who are optimistic – when we are optimistic, we actually don't reflect it. We don't say I'm gonna be optimistic now. We just are optimistic because we are hard-wired to be optimistic.

There's another way to do the same thing, which is deliberate – that's called strategic misrepresentation. So that's making your project look good on paper in order to have it approved. So if you wanna – any of us can do that – you have a project, you underestimate the cost, you overestimate the benefits, you get a nice benefit-cost ratio and your project looks like it's very

attractive on paper. That's strategic misrepresentation.

And that happens, too, you know, in megaproject planning. And the result is the same as optimism bias. So you get underestimated costs and overestimated benefits and underestimated schedules and the outcomes are the same, in that sense.

And we like to see the relationship between the two, the psychological explanations and the political explanations, as two types of bias that interact, so optimism bias and political bias. And in most projects, they both – they are both present. But they might have different relative strengths, so in some projects it's more optimism bias that are driving outcomes than it's political bias.

In other projects, like especially projects that have – where there is very high political pressure – like people high up and it might be – in the public sector, it could be politicians or high-level civil servants and in the private sector, CEO's and so on, they say I really want this project, then you'll find a lot of political bias in those types of projects, is what we see.

But in the vast majority of projects, we find that they are somewhere here in the middle. They have both optimism bias and political bias, and these are the two things that account for the cost overruns and the schedule overruns. That's how we explain it. Those are the two root causes and this is how they interact.

So finally, let's spend a few minutes on recommendations. So first, we saw what's the lay of the land in terms of numbers, what are the real risks here – the cost risk and the schedule risk. Then we try to explain what is generating those risks and we concluded two things are the root causes generating those risks: One is optimism and the other is strategic misrepresentation.

And then finally, what can we do to avoid cost overruns and schedule overruns? What can we do to avoid optimism and strategic misrepresentation? We have a whole set of different recommendations here. We talked earlier about the inside view and the outside view, and we talked about how the inside view

is common in planning megaprojects. And our recommendation is to take the outside view, and this is based on behavioural science, behavioural economics, specifically the theories that won the Nobel Prize in economics in 2002, won by Daniel Kahneman, psychologist at Princeton University.

He developed a lot of the thinking behind the planning fallacy and he – the outside view comes from him; it's his term. And he explains that the way to avoid the planning fallacy is to take an outside view – try not to understand your product from the inside, but just look at what do similar projects elsewhere actually cost, and assume your cost is going to be somewhere in the same ballpark. Unless you have very strong reasons to think that it won't; like your team is much better than these other teams that planned the other projects or whatever your reasons are.

We also recommend that organizations that are planning megaprojects and building megaprojects work with different budgets, so you actually – you want to have different budgets for different actors in delivering the project. So the owner might want to have a large contingency stashed somewhere. In case there are overrun, you actually wanna make sure you have the money so you don't get into a situation where you run out of money, which is one of the worst things that can happen to a megaproject.

So you have – like, what we call a P80 – that you have a contingency that will make it 80 per cent certain that you can stay within budget. But you don't wanna give that to the project director because you don't want the money to be spent just because they're there. So you give a contingency that is smaller to the project director that say – we call it the P50 – that the project director have a 50 per cent chance of staying within a budget, and you put even more pressure on the contractors – the builders. You might give them what's called a P30 to put real downward pressure on cost so that they don't get the sense that there's a lot of money here and we can just spend it.

So we actually don't believe in working with just one budget, that it makes much more sense – and this is being implemented in many places and many organizations that we work with, including governments. The Norwegian

government is doing this. The UK government is doing this. The Hong Kong government is doing this, and so this is something that is spreading right now. One of the newer things, like, not to think of budgets as one thing, but you actually have different budgets for different actors in the delivery.

So this is – there's a special methodology that we have developed called reference class forecasting. Again, this is a term – the term reference class forecasting, again, comes from Daniel Kahneman, the psychologist who won the Nobel Prize in economics in 2002, but he sort of threw it into a paper as a very short, off-hand remark that this would be a method that you could develop in order to take the outside view systematically on projects. And we then took the idea and ran with it and actually implemented in practice for megaprojects, both in the public sector and in the private sector. And we developed the data and methodology to do that.

It's been used on dozens and dozens – and probably more like hundreds and hundreds by now – projects around the world. And basically, what you do is that you identify a class of past similar projects, minimum of 20 to 30 projects like the one that you're planning. And then, on that basis, you establish an empirical (inaudible), so you work on the basis of historical data, instead of data that you assume will apply to your project.

You just look at what are actual historical data for other similar projects. And this has now been tested, you know? Like, doing forecasts like this or estimates of budgets like this has been tested against doing it by other methods, and reference class forecasting comes out as the most accurate method.

It's not like you get a totally accurate forecast. That doesn't exist. Anybody who tells you that you can get an accurate forecast would be a charlatan because of course that's not the way the future works – there's always uncertainty on whatever you do in the future. But reference class forecasting will give you the least uncertain forecast. So that has been documented. So that's part of the recommendation.

This is just some curves that are illustrating who you would use reference class forecasting in practice. You use it to adjust whatever cost estimate has been made. You use the reference class forecast, something called uplifts that are empirically-based. You say, okay, if we make this forecast and if we want 80 per cent certainty to stay within budget, then we have to adjust up by 70 per cent, you know, or whatever the data are, depending on the type of project that you're looking for.

Another type of recommendation here, on how to do things better, is oversight. So there's often inefficient oversight on megaprojects. It sounds – it might sound strange, you know, given the billions and billions that are used, but it's a fact that there's not enough oversight.

And governments right now are – some governments are working really hard to develop that capacity of actually having oversight. So the UK government has developed something they call the Major Projects Leadership Academy that I'm involved in running for the UK government, where they're developing all sorts of capacities, including oversight. So that's one of the things and the figure at the bottom is taken from the way that they – that the UK government are dealing with oversight. So you might want to take a look at that if you're interested in anything like that.

As part of oversight, we recommend independent reviews, like, people coming in totally from the outside and doing a review. In some countries, the national audit office is used for this, including in the UK and the US and my own country, Denmark. It's very common to have the national audit office go in and review projects like this.

There's also, like, more internal, more friendlier reviews that we call peer reviews, where you have peers – maybe people working in your government in other sectors, but having experience from this kind of project, and you invite them in to do a review of your project. They're not working on that project, so they're independent in that sense, and it's less formal. That has also been developed in the UK where peers from different parts of government review each other's projects to assess the risks and uncertainty on the project and how likely they

are to deliver to their business cases in terms of cost and schedule and more.

Accountability is something you also need. You need to hold forecasters accountable. You'll find that in many megaprojects that the people who are doing the forecast have no accountability at all. And it's a very new thing that this is beginning to happen, and there are different ways to enforce that accountability.

You can work at the incentive structure. You can have positive incentives that would make people more interested in actually meeting their budgets. It's called partnering. You can set aside a pot of money and you can say if you stay on budget, you're going to make this amount of extra money.

So instead of just having negative incentives, which, historically, has been the norm on megaprojects, many organizations are now experimenting with positive incentives where there's actually – the builders might make more money by actually delivering on budget and on schedule.

Transparency is an issue that – there's often a lack of transparency on megaprojects. Again, a general characteristic that many outside parties – many outside stakeholders are frustrated with the organizations running megaprojects for not being sufficiently transparent. Other parties feel that they should know more about what's going on. We have developed a whole set with two colleagues, I even wrote a book about this. How you can organize, how you can set up the planning and delivery of megaprojects in a much more transparent manner, including all the reporting that is needed and so on.

Transparency also relates to contingencies; how much should there be? How do you benchmark your contingencies? How do you decide whether a contingency is large enough or not? How do you make sure that a contingency doesn't get used just because it's there? It's something we call the red meat syndrome. That, you know, just because money is there, it tends to be devoured. And that's something you don't want to happen.

And finally, we have some recommendations regarding what we call smart scaling. How do you – it's basically consists of two things, one

thing is to – how do you speed things up? There's actually a very clear correlation between speed and performance. The faster you can do things in megaprojects without fast tracking, so the preparation has to be right, but once you go, go fast, the lower the cost overrun you get. So there's a strong correlation – negative correlation between the length of the phase – actually positive correlation, the longer you have the implementation phase of a project, the higher the cost overrun will be. And the faster you can do things, the lower it will be.

So that's one side of what we call smart scaling. The other is if you can build something in – as a combination of smaller units, you know, where you introduce an element of modularity, where you just do the same thing over and over, that generates a learning process that drives down cost. So, this combination of pace and modularity is what we call smart scaling, and it might sound something that hey, how do you do that for hydroelectric dam, but we've seen very creative project planners and project managers do it on projects where we thought it wouldn't be possible and they did it. So it's something that is worth thinking about we find on any type of project.

But, basically, summing up and wrapping up my presentation here regarding recommendation, there's really – there's three things you need. The first is you need a realistic business case upfront. You need a realistic frontend. You will not succeed with a project if you don't have a realistic business case and no matter how good a team you get to deliver your project, if the business case is crap, they're not going to be able to do it. And by that I mean, if the costs are way underestimated in the business case, no matter how good a team you get, they will not be able to deliver to that budget. And the same if the schedule is way optimistic. No matter how good a team you get, they will not be able to deliver to that.

So, therefore, the first thing is you need to have a realistic business case upfront, that's the first recommendation. You've got to make sure of doing that. The outside view, Reference Class Forecasting and so on is a way of getting that.

Second, you need to hire a high-quality team, somebody who really knows what they're doing

and somebody whose tried this before, who actually has experience in this area. That's more difficult than you think. This sounds like a no-brainer but once you go out there and try to find the last group of people who really know what they're doing in megaproject delivery, you will see how difficult it is. There's actually not a lot of talent. This is one of the reasons that Oxford University have decided to do a specific program in this training is because there are just not enough people with the qualifications to deliver megaprojects out there. So that's the second thing you need.

Then the third thing is you need to create a structure around this of accountability. So you actually hold the team accountable for what they are doing. So you actually hold the people who develop the upfront business case accountable for the business case. And there's a lot of elements involved in that like we just saw, but those are the three things: realistic upfront business case, a team that knows what they're doing, that have a documented track record of being able to deliver the project that you are delivering and then third, an accountability, an incentive structure around the whole thing so everybody is held accountable and incentivized to do what they're supposed to do.

Thank you.

THE COMMISSIONER: Go ahead, Mr. Learmonth.

MR. LEARMONTH: I have some questions, Commissioner.

THE COMMISSIONER: Go ahead.

MR. LEARMONTH: Would you please expand on the program at the Saïd Business School at Oxford that you're delivering? You mentioned that you have a course where people from all around the world, I believe, attend and they are taught what they need to know and learn in order to successfully run megaprojects.

Could you just describe how that course is set up, why it was set up and, you know, what type of people do you find as your students in this program?

DR. FLYVBJERG: Yes.

So it was set up, actually, by the – on the initiative of forces outside Oxford University, that contacted Oxford University and said, we need training in this and we want to start this at a university. And we're willing to fund this – put in a large sum of money to fund this for the first few years, but we believe that it will be able to fund itself once it gets going.

So, this was proposed to Oxford University and a couple of other universities, and I think three universities competed for, you know, coming up with a proposal for how to do this, and for that part of funding, and Oxford University won.

The program is called the MSc in Major Programme Management and it's an open-end degree program, so anyone can apply. However, there is a requirement – a minimum seven years work experience. So we won't accept anybody that has less than seven years work experience. And on average, actually, our students have 16 years, which surprised us. It's actually very senior people who apply for this program. We thought it would be, you know, closer to the seven years, but it's 16 years.

So these are senior managers in government, and it's both government and private sector, which is one of the interesting things. We are a business school, but we actually have a lot of people from government, which the business school loves, you know, because usually they only have people from business. And it – and the students love it in class that they get to talk across the public-private sector boundary during the education.

And, like I said, they come from many countries, like, all over the world. So, only 30 per cent come from the UK, the remaining 70 per cent come from all over: from Australia, South America, North America, lots from the US, people from Canada, people – I have two fellow Danes in the program right now. We have students from Google, from Apple, from defence ministries and from health, education and so on.

So it's not what type of sector you work in, it's really what type of program are you working on and anything that is as big as what we're talking about here today, so minimum \$1 billion and typically multiples of billions of dollars.

Actually, you know, things that are very expensive have one thing in common, they – that's the risk profile on cost and schedule and benefits. So, even if you work in completely different areas, you actually have a lot in common when you're working on these big things and what you have in common is that you're facing the same risks of not succeeding. And you need to do the same in order to succeed.

MR. LEARMONTH: Okay. Thank you.

I'd like to refer to Exhibit P-00004, Madam Clerk, if you could bring that up.

In your report, I believe it's at page 10 and 11, you refer to various classifications of megaprojects including megaprojects in mining and oil and gas projects.

Can you advise whether, based on your research and experience, the skills and experience of project management personnel in the oil and gas sector can be transferred from those types of projects to a hydroelectric dam and transmission megaproject?

DR. FLYVBJERG: I would say, yes, a lot of skills can be transferred and it would be a huge advantage that if you are working on any megaproject that you worked on another megaproject before. That being said, however, I would say that there also need to be people on the team who have specific domain experience from the – from dams, if you're building a dam. And so it would increase the risks if you took, let's say, two situations.

One situation: you have people who are – you only have people who build oil and gas projects before now doing a dam. That's one situation. The other is that you have people who built oil and gas but you also have people who have build dams before – large dams before – on the team. The first team would face larger risks than the second team because the second team has domain experience from the specific type of project that they are actually building.

MR. LEARMONTH: In your opinion, would a dam – hydroelectric dam and transmission megaproject have an increase risk if the project

management team did not have extensive experience in that area of work?

DR. FLYVBJERG: Yes. There are many things that are specific to a dam that you need to know about dams.

MR. LEARMONTH: Can you give us an example of the type of things that are specific to dams that wouldn't be present in, for example, an oil and gas project?

DR. FLYVBJERG: Yeah.

The science-specific work is very particular to the building of dams, so the digging out and the foundation you built and so on is specific to dams and different pretty much from anything else and, certainly, different from oil and gas projects.

MR. LEARMONTH: All right.

Professor, in some of your publications you discuss – or use the term confirmation bias. Please explain what confirmation bias is and whether there's a difference between the term confirmation bias and optimism bias.

DR. FLYVBJERG: So confirmation bias is that you tend to confirm the things you already know. So if you already know something you tend to confirm that when you study the world. So you could say that you are confirming your preconceived notions. Whereas optimism bias is being overly positive about something, like seeing the world through rose-tinted glasses, and thinking that something is going to take shorter than it actually is going to take and something being less expensive than it's actually going to be.

So they are very different biases.

MR. LEARMONTH: Okay.

Professor Flyvbjerg, in various megaprojects we see that consultants are often retained by management to provide advice on various issues, including risk assessment reports and so on. You've referred to consultants earlier, but I wanted to know whether in your research whether you found any indication that there's a

question of independence of these consultants who are retained by project management.

DR. FLYVBJERG: This is not a thing that we've studied as a systematic research project, so I wouldn't be able to comment on it on the basis of a specific research project. And I would say that from my experience it's impossible to do these risk assessments and other stuff on megaprojects without hiring consultants.

MR. LEARMONTH: Okay.

DR. FLYVBJERG: We all – I also have seen many examples of risk assessments produced by consultants that were very unrealistic, for whatever reason. It might be the optimism that we talked about. It might be that, you know, consultants would like to give clients what they want. So if the client wants a specific outcome – that happens sometimes. But there are limits to that. I mean, good consultants don't do that in the extreme, but within certain parameters that definitely happens in consulting.

Like we talked about earlier when you went through my CV, I work as a consultant; I work inside the consultancy so I know what's going on and so on. And so from my experience that there are these – I guess I would just call them additional biases in what consultants produce that could be from expectations from the client, and it could just be the normal biases that we talked about earlier.

MR. LEARMONTH: Thank you.

I'd ask you to turn to page 32 of your report, P-00004. Paragraph 4.5.3, heading: Private finance. Can you turn up that page, Professor?

DR. FLYVBJERG: Yeah, I brought it up.

MR. LEARMONTH: Yeah.

Now, I'm just going to read it into the record.

"Public financing and financing with a sovereign guarantee are often seen as less costly and less risky than private finance, because of the lower risk premium involved in the former type of financing compared with the latter. However, public financing or financing with a sovereign guarantee does not reduce risk or costs of risk. It

only transfers risk from lenders” – to ratepayer – “to taxpayers and is likely to increase the total risks and costs of a project.”

Now, what I’d like you to comment on is whether, you know, money saved by a sovereign or a government guarantee, which can often be in the range of 1 to 2 per cent, whether there’s any evidence that you’ve found that this may be offset by inefficiencies arising from related discipline and as a result of such guarantees. In other words, do sovereign guarantees, in your experience, really result in a saving to the project?

DR. FLYVBJERG: No.

It looks like it because obviously it – the government will be able to – or a loan backed by a government guarantee will have a lower interest rate. So obviously, that looks cheap. But you have – we have to understand why lenders are willing to loan at a lower rate. They are willing to loan at a lower rate because they don’t run the risk of the lender not paying because it’s guaranteed by the government. But that doesn’t mean that the risk has gone away. That just means that the government has taken on the risk and hasn’t priced it. But if the risk ultimately materializes, it will mean that the taxpayers have to cover it – and then it materializes. So even if it hasn’t been booked in the accounts, it’s a very real thing, it’s out there. And it does materialize often in the manner that I just described.

So the answer is no, it’s not cheap.

MR. LEARMONTH: And isn’t it true that if a project is financed by a private lender, more attention will go to cost estimates and so on, than would be the case when a sovereign or a government guarantee is available?

DR. FLYVBJERG: Well, actually that’s – often there’s this idea that the private sector is more efficient in this than the public sector, and we actually don’t find that in our data. So that’s one thing we are studying systematically.

And the private sector is making – is subject to the same biases that we talked about earlier and therefore is making the same error. So no, the private sector is not necessarily better. But if the private sector takes on the risk, at least it means

that the risk stays in the private sector and it materializes in the private sector. So that’s the main benefit of actually allocating risk to the private sector.

Ideally, you would think that the private sector would pay more attention when risk is allocated to them. But like I said, we actually find in reality that they are just as good or just as bad as government in doing this.

MR. LEARMONTH: Yeah.

I wanted to ask you if, in your view, it’s advisable when proceeding with a megaproject to involve interested parties – for example, environmental groups, interested Indigenous groups – at an early stage to ensure that issues are addressed up front, as opposed to waiting and seeing what happens as things progress.

DR. FLYVBJERG: Yeah.

So we’ve generally found that it does make sense to involve all stakeholders as early as possible. And that’s actually what we see; that is what good project organizations are doing. Because it’s like with the biases: if you don’t do it, it’s going to come back to haunt you. It’s not like these stakeholders will go away peacefully and say: Okay, we weren’t taken into account, we accept that and then we’ll go home and do something else. That’s not what happens. And it’s much more expensive to take these things into account if you have to do it later on in the process. So that’s the rationale for doing it earlier.

MR. LEARMONTH: And you’ve seen that as a – and you would consider that to be a general rule?

DR. FLYVBJERG: Yeah.

MR. LEARMONTH: Yeah.

DR. FLYVBJERG: I would.

MR. LEARMONTH: And is there more – do you see a trend whereby in other megaprojects that the proponents of the projects are dealing with issues up front as opposed to deferring the problem and dealing with it when a problem arises?

DR. FLYVBJERG: So, you know, different countries and different project organizations vary a lot on this. And I would also say that, you know, not necessarily all issues get dealt with up front. And that can be, you know, it can be difficult to deal with all the issues up front.

But I would say that good project organizations and the most advanced countries in this field, that's what they're doing. They are really trying to do this up front and they're trying to set it up – it doesn't mean that everybody is happy up front. I mean, there might be decisions made that certain stakeholders would be unhappy with, but it's dealt with up front.

MR. LEARMONTH: Okay, thank you.

Could you please turn to page 31 of your report, P-00004? Have you got that, Professor?

DR. FLYVBJERG: Yeah.

MR. LEARMONTH: Yeah.

Now, at the bottom paragraph of page 31, you state: "Thus, public sector organizations, should at the very least share internally with their planners the underlying unit cost in their projects to provide data for better inside view forecasts."

First, could you tell me what you mean by public sector organizations?

DR. FLYVBJERG: So those would be all organizations that are working for taxpayers' money.

MR. LEARMONTH: Okay.

Next, please turn to page 26 of your report. There, in paragraph 4.2.1, you – the heading is: Make de-biasing part of the stage/gate approval process. And you refer to the fact that: "In 2003 the UK Government introduced the concept of Reference Class Forecasting as part of the HM Treasury Green Book approval process for projects."

Were you involved in the introduction of that program, Professor?

DR. FLYVBJERG: Yes, I was. The UK government hired me and my team to develop that for the UK government back in 2004.

MR. LEARMONTH: Was the program developed and finalized?

DR. FLYVBJERG: Yes it was, and it's mandatory now in the UK.

MR. LEARMONTH: Okay.

Could you give a summary of the main principles that are addressed in that report?

DR. FLYVBJERG: Yeah.

So the main thing is that reference class forecasting was made mandatory in the UK for all transport infrastructure projects more than 5 million U – British pounds. So no authority in the government authority in the UK would be able to get funding for a project of £5 million or more if they didn't use reference class forecasts, so the outside view, basically, to forecast the cost of a project. So that was made mandatory.

At the same time, the incentives were also changed in the UK so that the local governments and different government bodies were also incentivized to produce realistic forecasts in the sense that they got skin in the game, so to speak, that before all costs were covered from the department for transport, for transport infrastructure projects in the UK, that was changed so that local authorities actually had to pay a certain percentage themselves. It varied for different types of projects but they would actually have their own money in the projects. So they couldn't just go back to London for more money if there were cost overruns, which had happened in the case before. Now, they actually would have to pay a part of that money themselves in order to incentivize them more.

So those were the two main things. And this was put into, you know, a formal government regulation so it got, like, the same status as if it were law, you know, and you had to do it. And it's been revised recently but it's still a principle – principally it's the same thing and it still applies in the UK.

MR. LEARMONTH: So the – since the reference class forecasting part was introduced in the UK, have you observed any improvement in the outcomes of megaprojects?

DR. FLYVBJERG: So we haven't done a study of UK projects. I believe the Highways administration did a study like that and they found that reference class forecasting was more accurate. But, as I mentioned earlier under my presentation, others have studied reference class forecasting in other contexts in other countries and documented that it is more accurate.

MR. LEARMONTH: Yeah. And you also refer on the same page – that's page 26 – that to the Hong Kong situation. I understand there have been – there's been the introduction of reference class forecasting in Hong Kong. Is that correct?

DR. FLYVBJERG: That is correct, yes.

MR. LEARMONTH: And were you involved in that initiative?

DR. FLYVBJERG: Yes.

MR. LEARMONTH: Yeah. So is it the same general system that we see in the UK?

DR. FLYVBJERG: The same general system but with more specialized data for different parts of government in Hong Kong. So they have a more detailed data collection system in Hong Kong where the data are more specific to exactly what it is that you're forecasting.

MR. LEARMONTH: Okay. And you were consulted on that?

DR. FLYVBJERG: Yes.

MR. LEARMONTH: Yes.

On the question of oversight, which is dealt with on paragraph 4.2 on the same page, 26, I wanted to ask you your view on what oversight mechanisms should be in place between a government and a wholly owned Crown corporation when the wholly owned Crown corporation is undertaking a megaproject?

You know, what type of oversight should the government have over the wholly owned Crown

corporation and what degree of separation, if any way – if any, should be created between those two entities?

DR. FLYVBJERG: Yeah, so, obviously, the government needs to have oversight that the Crown organization is doing what the government wants it to do. That's why it was set up in the first place, to do a specific job for the government, typically to deliver a specific project.

So that in principle is the answer, that the government needs to have set up an oversight system where they actually get the information that is relevant to decide whether the Crown organization is doing what it's supposed to do.

MR. LEARMONTH: Yeah.

And what, if any, obligation do you feel should be placed on a wholly owned Crown corporation with respect to disclosure when reporting to government on items such as cost schedules?

DR. FLYVBJERG: So our position on this is that the more transparency the better. So the Crown organization should be publishing everything at all possible, but we also know, of course, that there might be situations that, for legal reasons – non-disclosure agreements, commercially sensitive stuff and so on – there will be issues that can't be made public for those reasons, so – but that's general, I mean, that's normal throughout society.

MR. LEARMONTH: Yeah. But apart from those exceptions, for example, in the case of a binding non-disclosure agreement, should there be any restriction on the documentation and cost schedules that the wholly owned Crown corporation should present to government, we'll say, before sanctioning a project?

DR. FLYVBJERG: No, the more transparency the better. And this is general for megaprojects, as one of their big problems is that there has not been enough transparency, and that's one of the reasons they haven't been managed well. So the more transparency the better.

MR. LEARMONTH: Okay.

Now, on – in your report, specifically, page 17, 3.3.3, you refer to a term that actually you covered earlier, but the term I want to ask you about is political bias. Now, some, looking at that, might think that you're referring to politicians. Please tell us exactly what you mean by political bias and what groups of people are you referring to when you use that term.

DR. FLYVBJERG: So political bias is wider than just something that applies in the case of politicians. You know, most organizations have politics, and you don't have to have elected politicians involved in organizational politics for it to happen. So – and that's – we also sometimes call it political-organizational bias, so it's the kind of political bias that you find within big organizations. So it could be any actor that has a bias but, of course, the more important the actors are within the organizations, the more pronounced the political-organizational bias will typically be.

So you'll have people and teams jockeying for position within an organization and that can generate political bias. They want their projects to be approved and funded, and they will do what it takes to get it approved and funded. That generates political bias, and you don't need to have any elected politician involved in that for that bias to be there. So that's the sense we use.

MR. LEARMONTH: That's a much broader term than –

DR. FLYVBJERG: Yeah.

MR. LEARMONTH: – for example, saying it's just elected politicians.

DR. FLYVBJERG: Yeah.

MR. LEARMONTH: Yeah.

The – you've used terms – two terms that I want to ask you about. You've used the term reference class forecasting and the term taking an outside view, which I think – do you agree that both those terms were coined by Daniel Kahneman?

DR. FLYVBJERG: Yes.

MR. LEARMONTH: And – yeah. And is reference class forecasting simply the method for taking – that's employed for taking an outside view?

DR. FLYVBJERG: That's exactly it. So reference class forecasting is a method for systematically taking the outside view. It's actually an operationalization of the outside view that you can use on any project, not just megaprojects, but on any project.

MR. LEARMONTH: Yeah.

And is it correct that reference class forecasting captures a broader spectrum of risks that are not included in a typical quantitative risk assessment?

DR. FLYVBJERG: That is correct.

MR. LEARMONTH: Yeah.

Now, when one is applying this – carrying out this reference class forecasting, is it correct that there are two ways that it can be done? The first way it can be done is the – that the other projects that you're referring to can be used as an input into the Monto Carlo simulation? Is that correct?

DR. FLYVBJERG: Yeah, you can do that, yeah.

MR. LEARMONTH: Yeah.

THE COMMISSIONER: Maybe we could – just if we can break there, just for a second. I think it's time for a break, but when you come back, maybe one of the things you could do, Professor, is provide us with some sort of a description of what you mean by a Monte Carlo analysis. So – but I think we're going to take a break right now, Mr. Learmonth, if we would.

So we'll take 10 –

MR. LEARMONTH: Yeah.

THE COMMISSIONER: – minutes here now for break.

CLERK: All rise.

Recess

THE COMMISSIONER: So if we could have Dr. Flyvbjerg return, please?

All right.

Mr. Learmonth.

MR. LEARMONTH: Thank you.

I just wanted to note – make a correction – I believe at one point when I was discussing the exhibits, I incorrectly referred to the slide presentation as P-00008, where in reality it's P-00006. So if anyone was misled by that, that's the correction.

Okay, when we broke, Professor Flyvbjerg, I was talking about the use of the – the different ways you could use the reference class forecasting. For example, you could put it into the – use it as an input into the Monte Carlo, or you could use it as a stand-alone separate to compare with a Monte Carlo simulation without it.

Now, before we get into that, could you provide a summary of what a Monte Carlo simulation is and in what circumstances it is used?

DR. FLYVBJERG: Yeah.

A Monte Carlo simulation is a simulation of probabilities. So if you want to know the probability of some outcome, you make Monte Carlo simulations to figure out what the probabilities are and it establishes a distribution of probabilities of outcomes.

MR. LEARMONTH: Yeah.

DR. FLYVBJERG: So – and it's run on computer models and you – it's a standard tool. You can buy it, you know, off the Internet.

MR. LEARMONTH: Mm-hmm.

DR. FLYVBJERG: And the quality of the product really depends not on the Monte Carlo methodology itself, which is robust, it depends on the data that you input into the Monte Carlo simulation. So if you put in high-quality data, you'll get reliable results out of the Monte Carlo

simulation. And if you put in unreliable data, you will get unreliable results. As modellers say, garbage in, garbage out. If you put garbage in, you get garbage out. If you put good stuff in, you get good stuff out. That's the case for Monte Carlo simulations.

In megaprojects it's used for what's called QRA, quantitative risk assessments.

MR. LEARMONTH: Yes.

DR. FLYVBJERG: It's a standard ingredient in quantitative risk assessment in order to assess the probability distribution for –

(Inaudible.)

MR. LEARMONTH: What's going on?

Okay. Sorry about that.

DR. FLYVBJERG: No problem.

MR. LEARMONTH: I interrupted.

DR. FLYVBJERG: It happens to the best.

And it's used to assess the probability distributions of the outcomes of the important risks. So for instance, scheduled risk and cost risk in megaprojects.

MR. LEARMONTH: Yeah.

But it introduces a subjective element, does it not?

DR. FLYVBJERG: Depending on –

MR. LEARMONTH: Because you have to decide what the inputs are that you put in.

DR. FLYVBJERG: Depending on how you use it, it might introduce a subjective element, and it often does.

MR. LEARMONTH: Yeah.

DR. FLYVBJERG: And exactly for reasons we touched upon earlier that often the risks are assessed by risk experts that you get into a room and they assess the risk. They fill out questionnaires – how big do you think the risk is

of this and for that and so on. And like I mentioned during my presentation, experts are just as prone to bias, cognitive biases, including optimism bias as ordinary people are.

And, therefore, when you do it that way, when you create the data that go into the Monte Carlo simulation, which is the standard way of doing it, you actually do introduce a subjective element, namely the subjective assessment of the experts, which typically will be biased.

MR. LEARMONTH: Yeah.

So this is why you used the term garbage in, garbage out if you're – if you have biased inputs, or some biased inputs into the Monte Carlo simulation, then the result will be skewed because the inputs were perhaps optimistic or wrong.

DR. FLYVBJERG: Yes, especially optimistic – that's what we find. So we've compared a lot of Monte Carlo simulations with our reference classes in different areas and we find that in the vast majority of cases the Monte Carlo simulations are optimistic, meaning that they don't catch the big variation. You remember I showed you these numbers minus 47 to 5,000-and-something – that's widespread.

The Monte Carlo simulations will typically be much narrower and they will not include the very large risk in the tails of the distribution. That's the typical error that the experts make because they don't include all the risks, whereas reference class forecasting does include all the risks – even the famous unknown unknowns.

MR. LEARMONTH: The – well, there are unknown unknowns in the reference class forecasting, correct?

DR. FLYVBJERG: Correct.

MR. LEARMONTH: And includes unknown unknowns. But just for people to understand in simple terms – maybe I'm gonna oversimplify it too much, but if you – when you use a reference class forecasting, is it correct that you're looking at other projects similar to the project that you're undertaking and you're seeing the cost overruns, all the data that comes out of it, and when you look just at a scheduled cost estimate, it may be

biased, but if you look at the reference class as a check, you may come to think well, on this – using the Monte Carlo simulation it comes out at 5 billion, but we know by looking at the reference class that that is probably incorrect because the average cost overrun for projects like this is 43 per cent – is that a simplistic way to look at it?

DR. FLYVBJERG: That's a correct way to look at it.

MR. LEARMONTH: That's a correct way to look at it?

DR. FLYVBJERG: Yes.

MR. LEARMONTH: So you're always better off going with empirical facts rather than using a system that is prone to error because you may be putting in optimistic inputs. Is that correct?

DR. FLYVBJERG: That is correct, but I wouldn't discard the existing system totally. It has some benefits. It actually breaks down the project in smaller parts that you need in order to deliver a project. But often, the estimates for those smaller parts are biased. So we like to actually combine what we call the conventional approach with reference class forecasting. Using reference class forecasting to correct the biases in the conventional approach, and that way, you combine the two and you get a better result. You have the benefit of the breakdown of the conventional approach; you have the accuracy of the reference class forecasting –

MR. LEARMONTH: Yeah.

DR. FLYVBJERG: – approach.

MR. LEARMONTH: So you can use the reference class as an input into the Monte Carlo system, correct?

DR. FLYVBJERG: Yeah.

MR. LEARMONTH: You can do that. Or you can look at the – do the Monte Carlo simulation without the reference class, and then look at the reference class, compare it – compare the two?

DR. FLYVBJERG: Correct.

MR. LEARMONTH: Yeah. Which approach do you prefer and recommend?

DR. FLYVBJERG: I think either are okay. So the one where you run the reference class forecast by itself and then compare it to the Monte Carlo simulation is the most common. But you could avoid that comparison if you ran the Monte Carlo simulation directly on the data in the reference class forecast. That doesn't usually happen. Usually we are brought in later when there's – when there are problems in the project, and then we try to detect the problems, and we do that by detecting the biases, you know, to find out, okay, where did –

MR. LEARMONTH: Yeah.

DR. FLYVBJERG: – things start going wrong and how do we correct for this?

MR. LEARMONTH: Yeah.

DR. FLYVBJERG: So that's why you have the approach where you actually have – the Monte Carlo simulations are a separate thing; the reference class forecasting is a separate thing. Then you bring together the two to correct the Monte Carlo simulation.

MR. LEARMONTH: Okay. Thank you.

Now, I'd like you to turn to page 25 in your report, which is P-00004. And I'm gonna ask you some questions about the P-factors that are used in cost estimates. These – the – and then to be followed by a discussion about the red meat syndrome.

But anyway, the paragraph I'd ask you to refer – to which I want you to refer, is the second to last on page 25. I'm gonna read it.

“The P50 estimate is often used to forecast projects in a portfolio of projects, because in this manner on average underruns will compensate for overruns and the portfolio will balance overall. However, for big, one-off capital investment projects, decision makers will typically regard a level of 50% certainty to be ... low. In this case, decision makers would typically want estimates with a higher level of certainty for staying on budget, often 80 ...

(P80), i.e. estimates with a 20% probability of being exceeded.” And so on.

For – I'd like you to comment on the advisability of using P50 for a large megaproject that's a one-off. Not the portfolio system where there's the balancing, but using the P50 for a large one-off hydroelectric dam, for example, and transmission line. What would be your comment on the advisability of using P50 in those circumstances?

DR. FLYVBJERG: First I would say that it's – it would be uncommon to do that. It's not common to do it. And I would say it's only advisable if you have a high appetite for risk, you know, because you actually – if you use the P50, you have a 50 per cent risk of having a cost overrun. And a cost overrun on a multi-billion dollar project is, you know, is mostly a problem.

So I would say that if I were the advisor, I would have a very serious discussion with a client if they were deciding to go with a P50 for a multi-billion dollar project that is a one-off project, and – so it's not part of a portfolio. And I would say to that client that normally people are using a P80, and that's what I would recommend. Go with something between P70 and P90, I would say, and decide what your risk appetite is in that interval if you have a multi-billion dollar one-off project.

MR. LEARMONTH: Because the P50 introduces an element of risk that the P80 takes away, is that correct?

DR. FLYVBJERG: I would say it reduces it. It doesn't take it away, but it significantly reduces the risk because you'll – with the P80, you'll have only a 20 per cent risk of going over budget, whereas with a P50, you have a 50 per cent, so two-and-a-half-time bigger risk of going over budget.

MR. LEARMONTH: So you'd have a serious discussion with a proponent of a project – a large megaproject, one-off, using a P50 estimate?

DR. FLYVBJERG: Yeah.

MR. LEARMONTH: Yeah.

The – now, is a P50 really a P50 when we look at all the different biases that may go into that? Like, if it's used without a reference class examination, is a P50 really a P50 –

DR. FLYVBJERG: No.

MR. LEARMONTH: – in your experience and training?

DR. FLYVBJERG: In my experience, a P50 is usually somewhere between a P25 and P40 because of the biases we talked about earlier and because of the Monte Carlo simulations that we talked about not taking all the variations into account, underestimating the risks. So people think they have a P50, but they have something less than a P50 and, therefore, a higher risk of going over budget.

MR. LEARMONTH: Okay.

Is there a danger – a great risk – or a risk, I should say – in using a P50 for a one-off megaproject funded by a government in a sense that it can result in a vicious cycle, which you have written about in other reports. Do you know what I'm talking about? The vicious circle or the vicious cycle when you use a P50? Could you –

DR. FLYVBJERG: Yeah, so –

MR. LEARMONTH: Could you talk about that please?

DR. FLYVBJERG: So the – what we call the vicious cycle is – or circle – is the situation where a project – a big project gets into a situation where they have a big cost overrun. And what happens in that situation is that, typically, this gets on the front pages of newspapers; it gets in the media as a negative news story. So all of a sudden the project management on the project will have to spend substantial time on dealing with the media and putting out fires in the media, so to speak, as one thing.

The other thing is that if they have a big cost overrun they typically will also have to go and look for more money and spend time on that. So all of a sudden, the project management is distracted from what they were supposed to be

doing, which is delivering the project. This is really what you want to do if you were working on delivering a multi-billion dollar project. You want to focus on that. But suddenly the focus goes elsewhere. It goes to putting out the fires in the media and raising more money and whatever else follows from a large cost overrun.

And that means that the project doesn't get managed as well as it would have been if that hadn't happened, which will add to further difficulties for the project, for instance, delays and further cost overruns.

So that's why we call it a vicious circle, that it – these distractions lead to further cost overruns, so it's not only the initial first cost overrun but also later overruns that follow from it.

MR. LEARMONTH: Thank you.

I'd like you to turn to page 21 of the exhibit. In the second to last paragraph from the bottom you refer to the situation where: "In some instances ... the UK's High Speed 2 Project, decision makers have asked for a 95 level of certainty of estimates ... to evaluate the affordability and judge whether a project could bankrupt departments or private sector partners."

Now, in what circumstances would you recommend the use of a P95 for a project?

DR. FLYVBJERG: For an extremely conservative clients, but I actually probably would try to talk them out of it, because the kind of contingency you have to have to protect the last bit, you know, from 80 and up towards 100, the marginal cost of protection gets higher and higher, so you have to put aside more and more money the closer you get to 100, because of the tail risks involved.

And I would actually recommend, instead of using a P95, do something that we call black swan management. You actually don't want to have contingencies for the outliers for the black swans. You want to prevent them all together. And you can do that, so you can actually, you know, implement management measures that will reduce your likelihood of the black swans ever happening, and that would be a better use of resources than just passively putting aside huge contingencies for the extreme outliers.

MR. LEARMONTH: Yeah. So would it be fair to say a P50 is too low and a P95 is usually too high?

DR. FLYVBJERG: Yeah. That's what I would say.

MR. LEARMONTH: Yeah. And you would recommend something around – what range would you recommend for a big megaproject that's a one-off, not a portfolio project?

DR. FLYVBJERG: If I don't have any additional information I would say P80, but I would actually look at the specific data and see what the tail looks like, because you need to know what the specific risk is –

MR. LEARMONTH: Yup.

DR. FLYVBJERG: – and it might be that if the tail starts earlier than 80, then I would say only a P70 and then do black swan management for anything above that, but as – what we see is that it's usually around P80. So, yeah, I would say P80.

MR. LEARMONTH: Okay.

Now, I want you to refer to page 22 and 23 where you refer to a tiered contingency regime. For example on page 23, the third paragraph, you state: "A tiered contingency regime like those described above creates transparency about the risks taken on by each party working on" the "project. These regimes also introduce incentives that motivate each party to deliver according to their estimates and" increase "the likelihood of delivering project on budget and on time."

Could you just explain what a tiered contingency regime is?

DR. FLYVBJERG: Yes, a tiered contingency regime operates with different contingencies for different actions in the delivery of the project. So, you'd have one contingency in this diagram on page 22, indicated by the P30 for the contractors, you'd have one for the project director which is indicated by P50, and you'd have a third, the P80, for the project owner, and this is in order to put downward pressure on the

budget so that you don't get – the contingency gets spent just because it's there.

MR. LEARMONTH: Okay. So you'd have different levels of contingency – and these are referred to on page – you'd have different levels of contingency or P-factors for contingencies at different levels?

DR. FLYVBJERG: Yup.

MR. LEARMONTH: Yup. Is that done in Europe to your knowledge?

DR. FLYVBJERG: It is. It's done in Norway. It's actually mandatory in Norway that you have to use it, and the UK government is using it and Hong Kong is just implementing it now.

MR. LEARMONTH: Yeah. And can you report on the results that have followed the implementation of this tiered contingency regime? Do you have any data or information on that?

DR. FLYVBJERG: I don't have data. This is another area where we haven't done a systematic research study, so it's not like we have a lot of projects that have done this and we can now do rigorous statistical analysis like we saw earlier. So I don't have that kind of information.

I have information from working on these things and we see that it's being taken very seriously, for instance, by the UK government on very large projects, and what is taking seriously is that the contingency – let me put it this way to make it real simple, it has to be really difficult to get access to the contingency. That's how you need to design it. And that's how the biggest and most expensive projects in the UK are done now.

So in the UK, the Treasury is involved. So if you have to – if you're going to the P80 or P95, if we're talking about some of the UK projects, then you actually have to go to the Treasury and there's a whole set of conditions that need to be met or you're not going to get that contingency. And this is to make it difficult to get to the contingency, to protect the contingency, so to speak. So that's what you need to do there. But we only have this kind of project-by-project information at present.

In Norway, there's a research group that has studied this more systematically and they have found overall, they – it's not related only to the tiered contingency regime but they have studied the projects that are using the tiered contingency regime and found that they have lower cost overruns.

But whether it's because of the tiered contingency regime or other positive things that were implemented at the same time, we don't know.

MR. LEARMONTH: Yeah. I suppose in time there will be data provided on the benefits of the tiered contingency system that you'll be able to analyze.

DR. FLYVBJERG: We hope so.

MR. LEARMONTH: Yeah.

DR. FLYVBJERG: We hope so.

MR. LEARMONTH: Okay.

The – on page 23 of P-00004, under the heading 4.1.3, you write: "More accurate estimates and thus higher-quality project decisions combine the '*outside view*' and use of *all the distributional information* that is available. This may be considered the single most important piece of advice regarding how to increase accuracy in forecasting through improved" results.

Now, this is – you're referring to Kahneman in making that statement. I just wanted to confirm, do you agree with that statement?

DR. FLYVBJERG: Very much.

MR. LEARMONTH: Very much. That's the single most important –

DR. FLYVBJERG: Yeah.

MR. LEARMONTH: – factor, is it, the outside view and the reference class forecasting?

DR. FLYVBJERG: Yes.

MR. LEARMONTH: Yeah.

DR. FLYVBJERG: I mean, the reason the – all the distribution information is important is that the distribution information is what gives you the risk. So if you eliminate some of the distribution information it means that you eliminate information about a risk that is relevant to you. So that's why Kahneman and we too are emphasizing this that you want to include all information on risk that you can get your hands on when you're doing a project. And if you don't do that you're going to underestimate the risk. It will actually be part of optimism bias –

MR. LEARMONTH: Mmm.

DR. FLYVBJERG: – to disregard the risk.

MR. LEARMONTH: Yeah.

Now, you mentioned the red-meat syndrome earlier. Could you just go over what you refer to in using that term, and the possible ways to protect against this syndrome materializing?

DR. FLYVBJERG: Yep.

The red-meat syndrome is the assumption that contingencies are going to be spent just because they are just, like, lions will devour red meat just because it's there. So it's a point of view from, I guess, proponents of projects on how builders, contractors are viewing contingencies. And we find that it's more concern, actually, for less-mature project proponents than very mature project proponents.

So people who are usually doing megaprojects and do it all the time, they have learned how to deal with contingencies and have sufficient contingencies and actually don't want to start without sufficient contingencies. Whereas, less mature proponents will be afraid of contingencies because they are afraid they won't be able to manage the contingencies. And, therefore, they say we're better off not having the contingencies because that will force us to keep the cost down, and if we get the contingencies, we actually might end up with a project that is more expensive than it would have been if we didn't have the contingencies. That's the logic from this.

MR. LEARMONTH: What do you think of that logic?

DR. FLYVBJERG: I think it's fallacy, and I think that it stems from weak program management. Strong program managers know how to manage their contingencies and have a set-up where they can do it.

And the way it's done is you make it difficult to get access to the contingencies and you have strong management that know how to manage both the tendering process and manage the – whoever – builders or contractors are winning the tender.

MR. LEARMONTH: So the fear of building in a contingency is not something that you would expect in an experienced, seasoned project manager? Is that correct?

DR. FLYVBJERG: Yes.

MR. LEARMONTH: That's correct?

DR. FLYVBJERG: It is correct.

MR. LEARMONTH: Yeah. Okay.

Page 28 in your report, P-00004, the fourth paragraph under the heading 4.2.2. You state: "In addition, hidden agendas, hidden action and hidden information pose a hazard to the principal-agent relationship that may lead to political bias."

Could you expand on that point, Professor?

DR. FLYVBJERG: Yeah.

So that is the situation where, let's say a typical principal-agent relationship in delivering a megaproject would be the relationship between the owner and contractors. And contractors may have hidden agendas, you know, like, let's deliver this as cheaply as possible. And, obviously, that's part of the motivation for contractors.

And then, driven by that, might cut corners on projects and so on. It's very common that things like that happen. So that pose a hazard to the project. If you get that kind of situation, that means that the incentives are misaligned –

actually, the contractors don't want the same as the owner. The owner want the best quality project for the budget that has been allocated through the project; whereas, the contractor wants to make the most money out of building that project and maybe doesn't care much about other things there.

That's an example – a theoretical example of how this could be set up. And that is the kind of thing that you actually want to avoid, and that's what the partnering model is trying to avoid – is to align the incentives so that actually the contractors and the proponent have the same interests in delivering the project. For instance, by having this pot of money that I talked about earlier where contractors are incentivized if they actually live up to the goals that are set for the project delivery.

MR. LEARMONTH: Yeah. Thank you.

Professor, when you're assessing a megaproject, how much weight, if any, do you place on your assessment of the capabilities of the project management team?

DR. FLYVBJERG: Now, in what sense? You know, like –?

MR. LEARMONTH: Well, whether – you know, do you do a study? You know, do you form observations as yes, they're seasoned and experienced in the type of work they're doing, or they're not, or they need more experience? I mean, do you make assessments of your judgment of the quality of the project management team?

DR. FLYVBJERG: Well, that varies. So in my research, we – when we look at something like the numbers that I showed you earlier, we don't make any assessment on whether the management was good or not, but we do have – part of our research where we look at successes and see, okay, the projects that actually were built on budget and on time and delivered the benefits are better than those criteria – what happened? Where they just lucky? Or what are the things that the management team did that actually made it turn out as a success?

So we try to learn from that. So in that case, we do look very specifically at the management

teams and how they did it, and then we try to learn from that and bring it into other projects. So that's the research side.

On the consulting side, we very much look at the quality of the management team because if we get called in on a project, you know, they spent half the money and they only built a third of the project and now they don't know what to do. They know two things: They don't have enough time; they don't have enough money – what do we do? Then we need to know the quality of the management team and see where the changes need to be made to the management team.

MR. LEARMONTH: All right. Thank you.

Those are my questions, Commissioner.

I believe following the procedure that I proposed earlier that we'll now ask counsel for the parties with standing to ask their questions.

THE COMMISSIONER: All right.

So, I will now go to counsel with standing who have an interest in this area to ask if they have any questions of Professor Flyvbjerg.

So, first of all, the Government of Newfoundland and Labrador.

MR. LEARMONTH: Yeah.

Thank you, Professor.

MR. RALPH: Yes, Mr. Commissioner, we have a few questions.

Good morning, Dr. Flyvbjerg.

DR. FLYVBJERG: Good morning.

MR. RALPH: Welcome to Newfoundland and Labrador.

DR. FLYVBJERG: Thank you.

MR. RALPH: And my name is Peter Ralph. I represent Her Majesty the Queen in right of Newfoundland of Labrador. And the government is very happy that you've come all this way to share with us the very important work that you're doing.

And we're certainly interested in how your work can help us understand why there were cost overruns with regard to this project. We're the sole shareholder of Nalcor, which is the project proponent and manager of the project that is the subject of this Inquiry.

And you've described the outside view, and I guess reference class forecasting is the subset of that idea. How pervasive is that now around, I guess, the Western world or the entire world amongst countries? And, I guess, when did countries start adopting? You've mentioned 2003 in the UK. Was that the first – kind of first time this was adopted or has it been adopted elsewhere before that?

DR. FLYVBJERG: 2004 in the UK was the first time it was adopted, and since then it has spread so – like I said, it's become mandatory in the UK. It's also become mandatory in Denmark. It's mandatory in Hong Kong now. It's been used in South Africa. It's been used in the US, so it's quite widespread but it's not like a standard methodology that everybody is using. It's still, you know, a pretty young method and it's still spreading. But you'd find hundreds of projects that have been assessed by this methodology, if not more.

MR. RALPH: And if we spoke to these jurisdictions, they would use that language: the outside view, reference class forecasting?

DR. FLYVBJERG: Yes.

MR. RALPH: Is that right – yes?

DR. FLYVBJERG: Yeah.

MR. RALPH: And it's interesting to note that in the UK, it's required now for projects over £5 million – is that right?

DR. FLYVBJERG: To be specific, this is for the department of transportation –

MR. RALPH: Okay.

DR. FLYVBJERG: – so it's transport of products. And for the Treasury, they have set a limit at £40 million for any projects. So, any projects costing more than £40 million has to use it.

MR. RALPH: So, many projects that aren't considered megaprojects?

DR. FLYVBJERG: Yeah, yeah.

MR. RALPH: So is there a statistical difference in terms of cost overruns with megaprojects and projects that aren't megaprojects?

DR. FLYVBJERG: So you're talking about the size now –

MR. RALPH: Yes.

DR. FLYVBJERG: – measured like by the cost of the project?

MR. RALPH: That's correct.

DR. FLYVBJERG: Okay.

That varies a bit, but generally I would say no, there's not a strong relationship – which is surprising to a lot of people, including us at the outset, that actually the size of project is not the real drive of cost overrun; the length of projects is.

So time is much more important than size and money. So time size is more important than money size, that's how I'll put it.

MR. RALPH: Right.

DR. FLYVBJERG: That's what our data show very clearly.

MR. RALPH: Right.

So the things that you've suggested for megaprojects apply just as well in other types of projects.

DR. FLYVBJERG: That is correct, yeah.

MR. RALPH: You've talked about tiered contingency regimes, and I just wanna ask you I guess from a sort of a transparency perspective from government. You've talked about a P80 as a management sort of contingency – is that right?

DR. FLYVBJERG: Yeah.

MR. RALPH: And how do you envision that would work? Would that do something that would be – that wouldn't be known to most of the people working on the projects outside of management, is that correct?

DR. FLYVBJERG: Mm-hmm.

MR. RALPH: So that would still be part of the amount of money that a proponent would go to government for, for example, asking for funding. That would be in that budget –

DR. FLYVBJERG: Yes.

MR. RALPH: Is that correct?

DR. FLYVBJERG: Yeah.

MR. RALPH: But it wouldn't be advertised exactly what that money is for – I'm not quite sure how that would work in terms of a government needing to sort of be very public about what we're spending money on and getting a budget without being able to say exactly what the budget's all about.

DR. FLYVBJERG: Yeah, well, it depends on what level of detail you're working with the project on, you know. So it might just be the overall budget that is known and that is publicized and it hasn't been decided yet, you know, depending on the stage of project cycle you're in, exactly what each part of the project – when it's broken down – is going to cost.

But if I understand you right, I would say you are right, that in the typical Western democracy, once you have a budget like that and it's available inside government, it'll also be available outside government. So it's very difficult to keep things like that confidential. That will be known. And just with freedom of information legislation, you know, journalists and others would be able to get a hold of it.

MR. RALPH: Yes.

So that's more applicable to the private contexts than it would be the public –

DR. FLYVBJERG: No, I think it's applicable to both contexts. So you can use it in both contexts. But with a difference, that in the

private sector it'll be easier to keep things out of the public eye than in the public sector.

MR. RALPH: You've identified in your paper, I guess, the tension that exists often within governments, that they have often two roles that conflict. I guess many governments find megaprojects tantalizingly attractive, number of jobs and benefits that they're supposed to provide. At the same time, they're supposed to be guardians for the public interest in terms of taxpayers.

Now, you indicate in your report that the outside view, I guess reference class forecasting and perhaps tiered regime, can address optimism bias, but it doesn't address political bias completely.

DR. FLYVBJERG: It does address both biases.

MR. RALPH: But not completely.

DR. FLYVBJERG: Completely.

MR. RALPH: Oh, okay, I thought –

DR. FLYVBJERG: So let me see if I understand you correctly. So any bias will be eliminated by reference class forecasting. It doesn't matter where the bias comes from. However, we recommend that when you implement reference class forecasting, at the same time, you revise incentive structures. You also implement a different incentive structure that actually incentivizes the different stakeholders to behave in accordance with delivering what they're supposed to deliver. So, delivering on budget, delivering on schedule or whatever the objectives are.

MR. RALPH: Okay.

I just want to take you to, I think, it's P-00008, page 28 of your report – the last sentence of the first paragraph, page 28.

DR. FLYVBJERG: Exactly, yeah, so that's what I mean. That's why I'm adding the incentive, that you need the political bias, in order to eliminate it.

So the reference class forecast will eliminate it in the estimate. You know, you'll get a realistic

estimate that has not been influenced by political bias, you've actually de-biased that; but, in order to make the agents, the stakeholders act in accordance with what you want them to do, you need to implement this incentive structure that I talked about that will actually make them behave so you get what you want.

MR. RALPH: Now, you've suggested in your report that – and I think this has happened in the UK – that senior officials are now accountable directly to the legislature, as opposed to just sort of through their departments or through –

DR. FLYVBJERG: Yup.

MR. RALPH: – their minister? And so how does that work? Why is that important?

DR. FLYVBJERG: Well, that's just a measure that was implemented to create more accountability; to make sure that there's more accountability throughout the civil service.

MR. RALPH: And the idea is that's gonna affect the project manager's behaviour.

DR. FLYVBJERG: Yup, it is.

MR. RALPH: In your report as well you talked about, I think the subheading is Masterbuilder development, and on page 32 of the report you state: "Career advancement and development of civil servants tend to be tied to policy development" and "not delivery." Can you see that? It's the second sentence in that section.

DR. FLYVBJERG: Got it.

MR. RALPH: Can you explain to me how that works? I guess you're saying there's incentives or rewards somehow for policy development but not project management or delivery?

DR. FLYVBJERG: Exactly. We have found that the career structure for civil servants has emphasized more of a generalist, somebody has tried to be in many different ministries and know a bit of everything around –

MR. RALPH: Yeah.

DR. FLYVBJERG: – Whitehall, if we're talking about the UK, but whatever the

government is, and the people who are delivering projects, you know, who have responsibility for multi-billion-pound projects or multi-billion-dollar projects feel that it's not as good a career path, and they find that it's actually unfair, you know, that when you spend all this time on a big project, years and years to get your domain experience and be good at delivering, you don't have as good a career as the generalist who is jumping around and staying, you know, less than – I think it's – the average time that a civil servant is staying in one position is around two years or something.

MR. RALPH: Right.

DR. FLYVBJERG: And you don't develop the main experience for delivering a megaproject by just staying on a project for two years; you need to stay longer.

So that's the kind of skew in the career structure that this has been aimed at, and the UK government has taken that seriously, that we need to develop a better career structure for the people who are delivering our big capital investment projects.

MR. RALPH: And how have they done that?

DR. FLYVBJERG: So they've done it by setting up this major project leadership academy and just making it generally acknowledged that this is a career path and they're supporting it, both with training and with salaries and better positions, basically.

MR. RALPH: I think you've also stated in your report that – at the same page – I can't find it right now – perhaps it's lower down but – no, let's see – that public leadership and project planning and management is perceived to be lower.

Just a second – it's under Masterbuilder – no, no. I can't find it right now, but I'll just put it to you and you can – I think it's an accurate statement. I think I wrote it down word for word. Public leadership and project management – project planning and management is perceived to be lower in the public service than private sector partners.

DR. FLYVBJERG: Sorry, the last part again?

MR. RALPH: Public leadership and project planning and management is perceived to be lower in public service than private sector partners.

DR. FLYVBJERG: I'd like to see that sentence. Is it – it doesn't sound –

MR. RALPH: I'll find it for you.

DR. FLYVBJERG: It doesn't sound right to me.

MR. RALPH: I'll find it for you.

MS. O'BRIEN: I believe it's on the screen there, Mr. Ralph. If you'd just look at the screen – the paragraph highlighted there. Is that the sentence you were looking for?

MR. RALPH: Yes. That's right; it's a bit different. See that – start with "thus" – the paragraph that starts with "thus."

DR. FLYVBJERG: Yeah, that is true. Okay, so that is the perception that we've come across that the maturity of project leadership in the public sector is perceived to be lower. So the maturity and quality of project leadership in the public sector is perceived to be lower. And something that has contributed to that is that, actually, the public sector has outsourced a lot of the capabilities in major program and megaproject management that has contributed to this. So this is what we are talking about here.

And what's your question regarding it?

MR. RALPH: I just – so, you're indicating now that this is something that's happened over the course of time. That there would have been, I guess, a point earlier in time when this wasn't as true as it is now.

DR. FLYVBJERG: Yeah. But the key word there is "as true." I'm not saying that absolutely they have been the same. We don't know that, but we know that this has been a thing that has been developing over time, that the public sector feels that a lot of the skills they used to have have been outsourced and they, therefore, don't have them anymore. And, in some areas of government, the trend is being reversed and there are people arguing for that that should be

the case or that government is strong, because it's a problem.

If you have the public sector having to negotiate with the private sector, or with projects like this, which is always the case, and then the public sector is weaker in those negotiations because it doesn't have the same knowledge as the private sector, then you can get some bad contracts, you know, negotiated on that basis. That's the main concern here.

MR. RALPH: Yes.

So this would be true in all, sort of, stages of a project, be it planning or perhaps oversight, you would think?

DR. FLYVBJERG: Yeah.

MR. RALPH: You agree with that?

DR. FLYVBJERG: So I wouldn't make a blanket statement, like, it's always true, but it's a real risk, you know. And it's something that we actually pay a lot of attention to in our program in Oxford and in the training that we do with civil servants to make sure that their side of the negotiations is just as strong as the other side when you get people together to negotiate the contracts for these things. It's very important –

MR. RALPH: Yes.

DR. FLYVBJERG: – for the outcomes.

MR. RALPH: And I guess you've been involved in the development of some of the programs that have taken place in the UK to develop leadership skills?

DR. FLYVBJERG: Yeah, and elsewhere –

MR. RALPH: And –

DR. FLYVBJERG: – not just the UK.

MR. RALPH: – in Hong Kong?

DR. FLYVBJERG: Yeah.

MR. RALPH: And have they been on the go long enough to have an idea of how well they're working?

DR. FLYVBJERG: So, in the UK, they have tried to assess this. So the Cabinet office in the UK have made an assessment of how well they think they're going.

So I haven't made a study of this, personally, and I probably shouldn't because I've been involved in it, but the UK Cabinet office has – had tried to assess, you know, what are we getting by doing this; what are the benefits. So there is documentation from the UK government on how it works.

And the conclusion is that it's been a positive thing, and it's – and also that it's a long-term investment. We started this in 2012 and it's still ongoing. So it's something you need to keep at. It's not just the one shot in the arm and then this is fixed; this is something where you need to reverse a trend and build capability.

MR. RALPH: You discussed about having, I guess, one-third private financing in a large project. And any opinions about the importance of that when you're dealing with a large project in a small jurisdiction such as Newfoundland and Labrador?

DR. FLYVBJERG: I wouldn't be able to comment on the situation specifically here because I don't know it well enough, and our idea with proposing a third private (inaudible) is to get kind of a litmus test – what does the private sector think about a project like this? Under which conditions would they be willing to do it – like, what kind of subsidy do they need or how much are they willing to pay for it? You know, just to get an idea of how well it looks in the eyes of a commercial assessment.

You might not even want to involve the private sector beyond that. You might not decide to have them actually build the project, but you can still do the litmus test and ask them under which conditions would you be willing to build it, how does it look from you – this is, we find, highly useful additional information to get, even if you are doing a public sector project.

MR. RALPH: Right.

So it's not intended to address bias. It's not intended to address risk.

DR. FLYVBJERG: It's intended to address risk. It's actually intended to understand how would the private sector assess the risk for the public sector to get a reality check on their assessment of risk, right? So you get two different assessments of risk. One from the private sector asking under which conditions would you be willing to do that, this project, so you would get an idea of how much money would it take, you know, or how much money would you make from having the private sector go in, that would tell you a lot about the risk, and then your own public sector risk assessment also.

So we find that it provides for a more robust risk assessment. And we've tried it on multi-billion dollar projects –

MR. RALPH: Yes.

DR. FLYVBJERG: – and even, you know, a project that ended up being done 100 per cent public, but the private sector was involved in this risk assessment by them being asked under which condition would you do it.

MR. RALPH: All right.

Is there any magic to the one-third figure?

DR. FLYVBJERG: It's arbitrary, but this is actually a figure that I decided with the Danish Treasury. You know, I talked to the Treasury in Denmark and we tried to sit down and assess okay, how little is too little and how much is too much. How much do you need to have a real effect? And, you know, looking at different projects that we have studied and they have done, we landed on the 30 per cent. But I wouldn't say that that's written in (inaudible); it could be 40 or it could be 25. But I think if you go down to 20, 15, 10, then it's too little for it to have a real impact and real meaning for the private sector.

MR. RALPH: Thank you, Dr. Flyvbjerg. Those are my questions.

THE COMMISSIONER: Nalcor Energy

MR. SIMMONS: Good morning, Sir.

My name is Dan Simmons; I'm counsel here for Nalcor Energy. I have a few questions arising out of your report and some arising out of the evidence that you've given here this morning, which I think has been very helpful and very enlightening on many fronts.

The first thing I just want to confirm, though, is that as you've stated at the outset, your evidence, I take it, to be based on the body of research that you've done, your academic and consulting knowledge, but without any reference to the specific circumstances of the project that's being examined here at the Inquiry, which is the Muskrat Falls generating project and the transmission line project.

So that's correct, is it?

DR. FLYVBJERG: That is correct, yes.

MR. SIMMONS: Right.

So, essentially, all your evidence here today is derived from your larger understanding of megaprojects as a whole and some study you've done of hydroelectric projects in particular.

DR. FLYVBJERG: Correct.

MR. SIMMONS: Okay.

Okay. If I can take – go to your report first which I think is P-00004, and to page 2, please.

So on this page, Professor, we have a description of the three areas that you were requested to cover in your report. And your report is divided into three parts to deal with this. The first is a review of – on the international context of megaprojects and typical costs and schedule overruns; and second then you talk about causes and root causes of schedule cost overruns; and the third then is your recommendations.

So on the first of those, dealing with the statistical overview, in academic study, I take it that there are levels of maturity that we encounter for particular approaches, theories, developments. And that for the statistical review of these projects, would I be correct in thinking that there's a fairly high level of maturity that we can apply to this type of analysis?

DR. FLYVBJERG: So what exactly do you mean by maturity here?

MR. SIMMONS: The use of the methodology that you used in order to find the data about megaprojects –

DR. FLYVBJERG: Okay.

MR. SIMMONS: – and to do the statistical comparisons. There's not – wouldn't be a lot of the debate in the academic community or competing theories about how we go about a process like that.

DR. FLYVBJERG: Thanks for clarifying.

So, I will say that these are mature methodologies, both the way the data is collected and the way it's analyzed, as you rightly said.

MR. SIMMONS: Mm-hmm.

DR. FLYVBJERG: It doesn't mean that there are not discussions about these things in the academy. So, for instance, one discussion is like what should you use as baseline. That's why I pointed out earlier on, you know, that this is our baseline; that's how we measure.

MR. SIMMONS: Mm-hmm.

DR. FLYVBJERG: And one error that is often made – including with people doing reference class forecasting – is that they use data that had been measured at tendering as the baseline because that's a very common measure. Because you do want to know where the contractors are delivering according to the contract, right? So, data actually exists on that.

But, like I said, it's typically several years downstream from the decision to actually build the final investment decision of the sanctioning as I believe you call it here.

MR. SIMMONS: Yeah.

DR. FLYVBJERG: So those will give different results. And you make an error – if you think you're measuring the accuracy of a decision, and you're using tender data, you can't do that, and

vice versa, actually. So you need to be very clear of the baseline.

And there's some debate about that, you know, like, where the people have made an error of using data that was from the wrong baseline, technicalities like that, but important technicalities because, again, that would result in garbage in, garbage out, you know, if you made those errors.

MR. SIMMONS: So was there a good body of data existing before you began your work? Or was this a task that you and your team undertook to collect this megaproject data together to be able to make this analysis?

DR. FLYVBJERG: So there was no data set that was large enough to do statistical analysis on it when we started this. And this was one reason that we started it, that we wanted to see, okay, what are the scientifically valid answers on this.

So we did the first statistically valid study in this but, now, many more people have jumped in, you know, a long time ago. So many people have large data sets now around the world on these things, and you'll find many studies in the literature in addition to ours. We're not alone, fortunately. I think that it would be very unhealthy, you know, to be alone.

MR. SIMMONS: So in your data set – if I understand correctly, your review of megaproject costs includes projects that span a period of 50 or 60 years, some that go back a relatively long time?

DR. FLYVBJERG: So –

MR. SIMMONS: Is that correct?

DR. FLYVBJERG: I –

MR. SIMMONS: There are projects in your megaproject database that were completed several decades ago?

DR. FLYVBJERG: Yes. That's correct.

MR. SIMMONS: So for projects like that, and for projects that have been completed in various

jurisdictions – because I think there’s even some that were completed Soviet Russia, I believe –

DR. FLYVBJERG: Mm-hmm.

MR. SIMMONS: – how do you tackle the challenge of ensuring that you have proper baseline data when you’re doing the comparisons between estimated cost or a cost that was used at the time the decision was made for the project to go ahead, and the actual cost at completion?

DR. FLYVBJERG: So, typically, we would either get our data – like, documentation on the data – we try to use very high reliability sources. And so, for instance, we don’t take reported data. Somebody tells us, you know, this was the cost overrun that happened to this project, like, a verbal communication is – we know from experience that that is not sufficiently reliable.

So we prefer, you know, written documentation or we’d be using data from what we consider reliable sources. Like, for instance, if you take the National Audit Office in my own country, Denmark, and in the UK, here in Canada, I would say that they have pretty high standards and they collect their data the same way we do. And it’s fairly transparent and we can talk directly with people and so on.

So that’s the way we do it. We actually assess every case and assess whether we have a solid foundation for saying this is – these are the numbers and they were using this baseline a lot. We have lots of data that we’ve thrown out because we couldn’t establish this. If we don’t know what the baseline is, then we don’t include the data.

MR. SIMMONS: Okay, good. Thank you.

So the second topic that you’ve addressed in your report that’s listed here on page 2 of the report is you were asked to look at causes and root causes of cost and schedule overruns. And I’ll ask you the same question about the maturity of the work, and not just your work, but the academic and analytical work that’s out there now on that issue.

Because it would seem to me that the question of cause is a more complicated one than doing a

statistical analysis and drawing comparisons of estimated cost and real cost. And I think I’ve understood, for example, that the concept of optimism bias has originated from behavioural psychology and has been applied in this context, right?

DR. FLYVBJERG: Correct.

MR. SIMMONS: So how mature would you say the current level of analysis and understanding of root causes is of the cost overruns and megaprojects?

DR. FLYVBJERG: Again I will say very mature; mature to the degree that these are theories that won the Nobel Prize in economics.

MR. SIMMONS: Mm-hmm.

DR. FLYVBJERG: So you don’t get it much more mature than that in social science, so very well founded.

And that goes for both the optimism bias and the political bias. The political bias theory is based on principal agent theory, which is more political science, economics kinds of theory. And, again, they have been around for decades and are considered very solid in the academy.

MR. SIMMONS: Mm-hmm.

DR. FLYVBJERG: So I would say that, again, on the theory side, the root cause side, this is mature work.

MR. SIMMONS: Okay.

I’ll give you a more lay example and just ask you to comment. In history – in the study of history, I know there have been different theories over the last number of decades about what the proper theoretical approach is to analyzing historical events.

And there have been approaches that have been adopted and have come in favour and have fallen out of favour and have changed over time. Is there any history of that sort of debate or changing view about the root causes in the area of your work?

DR. FLYVBJERG: Yes, there is. So like I mentioned earlier, the technical explanations were totally dominant until 15-20 years ago. And it's only with the rise of behavioural science, behavioural economics, behavioural psychology that these other explanations have come up, have surfaced and become dominant in their turn. So it's like what's called a Kuhnian paradigm shift. It's a real paradigm shift within academia what has happened.

Now, that doesn't mean that it won't happen again.

MR. SIMMONS: Mm-hmm.

DR. FLYVBJERG: And you are absolutely right about theories, explanations changing all the time. And that's just the nature of the beast and I would say even in physics that's the case, you know? Like, over time you have different theories and we keep chipping away on things and testing things and criticizing things and being skeptical of things, trying to falsify things – that's academic work. And only the theories that can stand that process get to hold up. And the others will fall by the wayside and other stuff will come up. And I have no doubt this will happen in this area also. That's – I would be very disappointed if it didn't because it would mean that we have no progress. So that's the way I see it.

MR. SIMMONS: So you still expect then there to be at least some evolution in thinking about how root causes are identified for megaproject costs and schedule changes, if not some larger change in the future as more research is done and more academic thought is applied to it? Is that a –

DR. FLYVBJERG: Yeah. And I've –

MR. SIMMONS: – fair statement?

DR. FLYVBJERG: – already experienced two of those changes. So one was that the technical explanation sort of disappeared by the wayside. And they are not really considered powerful explanations, even there are still people who subscribe to these. And the second was that the psychological explanations and the political-economic explanations were living separate lives, you know.

MR. SIMMONS: Mm-hmm.

DR. FLYVBJERG: So the psychologist would explain in one way and the political scientist and the economist would explain in another way and there was no dialogue between the two. That was brought together at one stage by a very specific intervention by a *Harvard Business Review* editor who said hey – to Kahneman actually – you are explaining things in this way, and to me that you are explaining things in this other way – this was back in 2003.

And he invited both of us to write comments in the *Harvard Business Review*. And basically we concluded, hey, this is stupid that we are separate. These are actually two types of explanations of the same phenomenon and they're both relevant. They supplement each other. They're not competing explanations, they supplement each other. And they come together like I showed in that diagram earlier.

So that's that kind of development in the thinking. And I certainly hope there will be more of that.

MR. SIMMONS: Okay.

So the third area then that you've addressed in your paper and your presentation is the recommendations that you've made for ways to address the biases that you've identified. And I'll ask you the same question about the level of maturity of the development of those recommendations. And I'll use another example from somewhere else that may be applicable or may not be.

In industry, in industrial processes in plants, there's various models that are out there that are continuous improvement models that involve identifying a problem, collecting data, analyzing the data, coming up with a solution, applying it, starting over again by collecting the data, analyzing the data, measuring the effect and the idea being that there will be a continuous circle of activity designed to continuously improve the product, but it always involves measuring the results of what's been done.

So given the – that the theories around optimism bias and political bias are relatively new and that you've made a set of recommendation here, how

mature are those recommendations? Are they ones that have been thoroughly tested, have gone through the cycles of continuous improvement and are ones that we can now accept as being the best state of the art? Or is this still a work in progress, where there's still work to be done to evaluate the best way to deal with these issues – long question.

DR. FLYVBJERG: Yeah. It's a great question and I think the weak link here is measurement, as you rightly emphasized, that when you have a quality circle like what – that's what I would call, what you're describing, a quality circle that you get going where you keep improving your product. It actually requires measurement and there's not a lot of measurement. You'd be surprised that people invest these billions and billions of dollars and they actually don't go back and measure what happened and keep solid records.

One reason is that it takes so long to do these projects that, you know, a lot of people think, hey, it's irrelevant anyways, now it's taking 10 years to deliver this project from where you had the idea until it's actually online. And technology, politics, policy, everything has changed in the meantime so it's not so relevant anymore and, therefore, they don't bother to collect the data and measure. And that's a huge drawback because you can't get the quality circle going if you don't do that. So that's a weakness I would say. And in that sense I would say it is a work in progress.

MR. SIMMONS: All right.

So the unavailability of the good data that you'd like to have in order to be able to evaluate how these recommended measures work, how does that affect your work as an academic who's working in this area? Does that make it harder for you to develop recommendations? Does it make it harder for you to be confident that the recommendations you make are the ones that will help solve these problems?

DR. FLYVBJERG: It doesn't make it harder to be confident, it makes it harder in the way that it makes it more time consuming.

MR. SIMMONS: Mm-hmm.

DR. FLYVBJERG: So if I were somebody starting the labour markets, I could go to the national bureau of statistics and get lots of data on how the labour market is performing. Or if I was studying GDP, you know, there's lots of unemployment, there's lots of data on that that are produced routinely by the system of government.

This is not happening with megaprojects. There's nothing like that. There's not a bureau you can go to and say, hey, I'd like to download your data on megaproject performance. So we actually have to develop the data collection formats and actually collect those data ourselves. That is very time consuming.

That's how it's harder, but once we have the data and we have relevant, reliable data, we actually trust our recommendations very much.

MR. SIMMONS: Okay. Thank you.

I now – I have some questions now that are more directly from your report. And I'm going to go back to the collection of the megaproject data and your analysis of it. And maybe we could go to page 6 of the report, please, which is the start of part 2.

So the first question is you've spoken about collecting the – about the need to have good base cost data when you're doing a cost comparison to know that you're measuring it on a consistent basis. We know that estimated costs, in some cases, will include more than just the estimate for each task of doing the work; that they will include components for escalation of prices over time, for example, or some contingency that's been arrived at as a result of a QRA, quantitative risk analysis-type work.

In the data that you have, were you able to identify whether those types of escalation or contingency matters were included within the base cost estimates that you used?

DR. FLYVBJERG: Yes.

MR. SIMMONS: And I presume then that what you did was you factored those out so you got back to just a base estimate for the actual performance of the work before you looked at

the amount of escalation or cost growth on the project.

DR. FLYVBJERG: Yes.

MR. SIMMONS: Yup. Okay.

And do I understand correctly that you actually did some new work and added some more projects to your database for the purchase of the – for the purpose of this report that you did for the Commission?

DR. FLYVBJERG: Yes.

MR. SIMMONS: Okay.

DR. FLYVBJERG: Correct.

MR. SIMMONS: Because we – one of the reports that you've cited that you had done earlier, one of the articles from 2014 was the article: Should we build large dams published in 2014. And I believe that was one where you had a database of some 200-plus hydroelectric projects.

DR. FLYVBJERG: I believe it was –

MR. SIMMONS: Or, no, not that many.

DR. FLYVBJERG: – 186.

MR. SIMMONS: 186.

DR. FLYVBJERG: Yeah.

MR. SIMMONS: So for this report, what were you able to do in order to build on that database? Can you give me an idea of how you added and supplemented your database of hydroelectric projects?

DR. FLYVBJERG: So this is something that we do on a continuous basis. We're constantly expanding our database. So, basically, we monitor this area worldwide. We monitor what's going on, what new data are appearing, and we update our database a couple of times a year where we add new data.

So that's simply what we did for a dam, so the time that has passed between 2014 and now, these additional projects have come up with data

and we added them to the database and to the study here, which we would have done if we'd done an academic study, and which we do here.

And it would be wrong, according to this mantra that Kahneman has developed, that you need to include all distribution information that's available. So if we had just left this out it actually would mean that there's distribution information out there on the risks in hydroelectric dams that we didn't take into account in this study, which would actually make this study less strong than it is now with the data included. So that's the rationale behind it.

MR. SIMMONS: Okay.

Can we go to page 11 of the report, please, P-00004.

And I'm not sure if I've got a mouse here that I can scroll with. No?

MS. O'BRIEN: You don't. Madam Clerk does, and she can scroll as you go.

MR. SIMMONS: Okay.

Well, just scroll down a small bit, please. Okay, that's good.

So this is the point in your report, Professor Flyvbjerg, that you have a table there which compares mean cost overruns, frequency of cost overruns for hydroelectric projects in Canada versus the rest of the world. I think I have that correct?

DR. FLYVBJERG: Yes.

MR. SIMMONS: Yes.

And you've said that in Canada the mean cost overrun is 41 per cent and by mean, is that the average?

DR. FLYVBJERG: That's the average. Correct.

MR. SIMMONS: Okay.

So that's – and the frequency of 50 per cent means 50 per cent of the projects had a cost overrun in Canada.

DR. FLYVBJERG: Correct.

MR. SIMMONS: And 13 per cent had a schedule overrun. Oh, I'm sorry, the mean schedule overrun is 13 per cent and the frequency was 50.

DR. FLYVBJERG: Correct.

MR. SIMMONS: And in the rest of the world all those numbers here seem quite a bit higher.

DR. FLYVBJERG: Correct.

MR. SIMMONS: And if I understood your evidence earlier it was that although there are not enough samples here for it to be statistically significant, just to bring – make it statistically reliable, we could still draw some inferences from the numbers that we see in this table.

DR. FLYVBJERG: So, first of all, the difference is statistically significant for schedule overruns. So the 13 –

MR. SIMMONS: Oh yes.

DR. FLYVBJERG: – versus 43 are statistically –

MR. SIMMONS: Right.

DR. FLYVBJERG: – significantly different; whereas for the cost overrun it's not the case. So what I see here and what I mentioned earlier is that the difference between 41 per cent and 99 per cent strikes me as it's a big difference. And my expectation would be that if we got a larger sample for Canada – you know, it's only 19 projects.

MR. SIMMONS: Mm-hmm.

DR. FLYVBJERG: And that means that there's a lot of uncertainty and variation that comes from just it being a small sample. The larger the sample you get, the more reliable the data are, and I would think that there's a big chance that the difference between Canada and the rest of the world would be statistically significant if we

got a larger sample for Canada, but I can't know for sure, but that's just my experience with numbers like this that tells me.

MR. SIMMONS: In the 2014 article I referred to a moment ago about, you know, whether we should build large dams, you used in that article, I think, your database of hydro – worldwide hydroelectric projects.

DR. FLYVBJERG: Correct.

MR. SIMMONS: And in that case, if I recall correctly, there's a world map where you break down the cost – the average – the mean cost overruns by continent –

DR. FLYVBJERG: Correct.

MR. SIMMONS: – essentially, where you grouped North America, Canada and the United States together, and the – in looking at that – the largest overruns seem to be in Soviet Russia, and followed by South America, India and then declining to where North America had the smallest cost overruns –

DR. FLYVBJERG: Correct.

MR. SIMMONS: – for those hydroelectric projects.

DR. FLYVBJERG: Yeah.

MR. SIMMONS: So my question is when you approached it that way, treating North America as a unit instead of just Canada alone, can you recall whether there was a statistically significant difference between North America and the worldwide average?

DR. FLYVBJERG: I'm not 100 per cent sure, but – yeah, I'll have to check that.

MR. SIMMONS: Mm-hmm.

DR. FLYVBJERG: But I think there probably was, but I'd have to check it.

MR. SIMMONS: Yes. And it was a fairly significant difference –

DR. FLYVBJERG: Yeah.

MR. SIMMONS: – in that case –

DR. FLYVBJERG: Yeah.

MR. SIMMONS: – between North America –?

DR. FLYVBJERG: Yeah.

MR. SIMMONS: Okay.

So to jump ahead a little bit to –

DR. FLYVBJERG: And just to answer that, that actually – if it's correct, that supports what I'm saying here, because, by including the US, you get a much larger sample than I had seen, right? And then you'd get significance. But that was just an added comment.

MR. SIMMONS: So to jump ahead a bit now to the reference forecasting that you're saying is an important tool that can be used for estimating the cost of megaprojects, in particular hydroelectric megaprojects, where would the reference cases be drawn from for a project in Canada? Would you promote only using other projects in Canada? Would you say it should be North America, or would you say it should be the average of the whole world?

DR. FLYVBJERG: So we have a very rigorous procedure for deciding this and that is that we would include any projects that are statistically comparable to Canada.

MR. SIMMONS: Mm-hmm.

DR. FLYVBJERG: And this is something you can establish by statistical tests. So if we would test Canada against the US and we would see, okay, if they are statistically similar, meaning that there's no documentable statistically significant difference between the two countries, then we pool them. Then we'd look at Europe, and we'd see – do the same test: is there any difference? If there is no difference, they would be pooled; if there is a difference, we don't pool them.

We'd go to Russia; we'd go to – you know, if we have data from China, South America, we do the same thing. We test these things.

And a statistician would argue that anything that behaves similarly statistically is similar statistically, and therefore, you should include it.

There are certain, I mean, boundaries that I don't wanna cross, you know. Like, one of our statisticians once told me that you can actually use the data for underground metros to predict the cost of opera houses. And I said, I don't even wanna go there, you know, because even though, statistically, they are similar – so the cost overruns on opera houses are the same as cost overruns on subways – that doesn't mean that I wanna use the data from the subways to predict the cost of opera houses, even though a statistician would actually argue that you can because you don't need to have additional information. You just need to look at the statistical behaviour.

But to get back to your question, the way we test this is by statistical similarity between projects. We might also decide that some jurisdictions are so different from Canada that it doesn't make sense to compare projects there with Canada. That's an additional argument.

But basically, this is the discussion that you take, you know, you sit down in a group and you discuss which projects should go in the reference class that we are going to use to predict a dam in Canada and you would have that discussion, and then you would run these statistical tests where you actually test whether the data behaves similarly statistically –

MR. SIMMONS: Mm-hmm.

DR. FLYVBJERG: – and only if they do would you pool them.

MR. SIMMONS: So is it correct to say, then, that there is still some subjective element in the selection of the reference cases to be used in that process and that some person, or group of people, are going to have to evaluate specific other projects to determine whether it's appropriate to include them in the set that the proposed project is going to be compared to?

DR. FLYVBJERG: That is correct. And that's where optimism bias, again, you know, can enter into the whole exercise through the back door if you're not careful.

MR. SIMMONS: Mm-hmm.

DR. FLYVBJERG: And that's why we run these objective statistical tests on the numbers, and we don't leave it to people just thinking, hey, I think this project should be in this reference class or not. That's not good enough.

MR. SIMMONS: Mm-hmm. Okay.

Can we scroll up, please, to page 10? There's another table on page 10, before that – a little bit higher, please.

Okay, this is the table where you've compared different types of energy projects. And this is worldwide data, I think, is it?

DR. FLYVBJERG: Yes.

MR. SIMMONS: Yes.

Okay, and this is where you've identified that nuclear carry the highest risk of cost overrun, and then you've spoken about what the statistical significance there. I had a question for you about the thermal line there, so "Thermal (oil, diesel, gas, coal)." So these would be hydrocarbon-fired, electric-generating plants? Would it? We're talking about here?

DR. FLYVBJERG: These are power plants that are fired by either oil, gas, diesel or coal.

MR. SIMMONS: Right. And these are – would it be fair to say that plants of this sort are relatively more common than large hydroelectric developments in the world?

DR. FLYVBJERG: Yes.

MR. SIMMONS: The – and the experience with those has been that while cost overruns are not on average as high as for hydroelectric dams, still, 59 per cent of those projects do experience cost overruns –

DR. FLYVBJERG: Correct.

MR. SIMMONS: – over and above what was estimated at the time that the projects were sanctioned?

DR. FLYVBJERG: Correct.

MR. SIMMONS: So that for those projects – those making the decision for them to go ahead, after they'd gone through the conventional processes of trying to assess contingencies and risks, still failed to anticipate what the total cost of those projects would be –

DR. FLYVBJERG: Correct.

MR. SIMMONS: – in 59 per cent of the cases?

DR. FLYVBJERG: Yes.

MR. SIMMONS: Okay.

Back to page 11, please, if we can scroll down. Okay. A little farther please. Okay, you can stop there. There's a paragraph here, Professor, that begins: "In mining?"

"In mining, oil and gas projects Canadian projects have statistically significantly lower cost overruns (Canada 13%, rest of the world 44%)."

And you'd been asked a question by Mr. Learmonth concerning use of oil and gas management expertise on a hydroelectric project, and I took your answer to be that it is valuable expertise that can be applied, but that you'd still see the value of having some specific hydroelectric management expertise involved in the project.

You're nodding your head, so –

DR. FLYVBJERG: Correct.

MR. SIMMONS: – I've got that right.

DR. FLYVBJERG: Yeah.

MR. SIMMONS: So my question is: Is the usefulness of having people experienced in oil and gas projects involved in a project in Canada heightened because of the good experience that the oil and gas projects have had in Canada with controlling their costs compared to the rest of the world? In other words, is there a greater advantage in Canada, even than in the rest of the world, drawing on that expertise?

DR. FLYVBJERG: I would say yes to that.

MR. SIMMONS: Thank you.

So I have some questions for you on optimism bias. And I'd like to go to the example that you've used in your report from Ontario Power Generation with the Niagara Tunnel Project case. On page 14, please. So scroll down a little more, please. Okay, stop there.

So you've described the project in your report and in your direct evidence. And in the report here you've listed a number of items, four bulleted items that were put forward, I understand, as being explanations – you call them excuses – for the increased cost on that project. For example, the first one said there were “worse than expected conditions” in the rock once the tunnel passed a particular point. And I think for projects involving excavation or working underground, geotechnical conditions are a classic risk that are encountered – that's encountered on them.

And do I understand correctly that there's probably two ways that optimism bias could play into a problem like that? And I'd like your comment on whether I'm right or wrong, or you can set me straight.

One way is that the planners for the project could be – their optimism could cause them to not investigate, sufficiently, the geotechnical conditions and proceed with the project. The second way might be that their optimism would cause them to not allow for adequate mitigation of conditions that are known. So in the one case, there might not be enough investigation done, and in another case there's more investigation done, but there's an opportunity to mitigate which isn't fully taken advantage of. Could optimism bias come into play in both of those –

DR. FLYVBJERG: Yes.

MR. SIMMONS: – circumstances?

DR. FLYVBJERG: Correct.

MR. SIMMONS: Okay.

So in my second scenario, if a risk is identified – such as a risk of adverse geotechnical conditions – is a way to mitigate the effect of the optimism bias to ensure that there is a more detailed

investigation done, so that those planning the work, actively turn their minds to how they're going to mitigate that risk; is that a way of helping offset some of the optimism bias that might be at play?

DR. FLYVBJERG: It is a way, and this is a way that I've seen in projects. But again, assessing the mitigation measures – as you rightly point out – people can be optimistic about that.

MR. SIMMONS: Mm-hmm.

DR. FLYVBJERG: So people – I've seen examples of people being hugely optimistic about how effective mitigation measures would be and they turn out to be much less effective when they needed the mitigation measures, when they actually had to be implemented.

MR. SIMMONS: Mmm.

DR. FLYVBJERG: So that's something to be aware of – if you think you're developing mitigation measures as a cure for optimism bias – to make sure that you didn't just roll the optimism bias into your assessment of the effectiveness of the mitigation measures.

MR. SIMMONS: Mm-hmm.

So would one way, then, to address the effectiveness of mitigation measures and to try and counter the optimism bias that might even be built into that – is that where the outside view, that you talk about, comes in?

DR. FLYVBJERG: Yes.

MR. SIMMONS: Okay.

THE COMMISSIONER: Just if I can, it's – I see it's 12:30 now. My plan had been to take a break now for 45 minutes. Is it – would it be too much of a disturbance to your examination if we were to do that at this stage?

MR. SIMMONS: Not at all, Commissioner. If it – it may help.

THE COMMISSIONER: Okay.

So if that's the case, we'll break now for 45 minutes. I plan to start again, sharp, at 1:15 this afternoon.

This is the one day that we – our schedule is a little bit off because we're trying to accommodate Professor Flyvbjerg. So I expect everybody back at 1:15 and ready to go.

All right, so we'll adjourn to 1:15.

CLERK: All rise.

Recess

THE COMMISSIONER: Thank you for your promptness.

We're actually gonna be starting a little early, which is great. I hope that's a continued record as we go through.

Mr. Simmons.

MR. SIMMONS: That's even better than on time and on budget, Mr. Commissioner.

Professor, we were looking at your report, Exhibit P-00004, and I'd like to go, please, to page 8. There's a couple of charts or diagrams here on this page that I think you pointed us to it before.

And if I understand correctly, the one on the left is a chart that charts the – compares estimated cost to actual cost for megaprojects, and the one on the right deals with schedule, comparing actual. And you had used these before, I think, to make your point that there hasn't been any real change over the time period spanned here, which goes back to about 1940, in the success of megaprojects meeting their cost and schedule.

So if we look at the one on the left, do I understand correctly that the vertical scale on the left of that chart, the number 1 indicates that a project was – the cost was as estimated? It was completed for its estimated cost?

DR. FLYVBJERG: Yes.

MR. SIMMONS: A project that's at the 2 level – I dotted the 2 – does that mean that it cost twice as much as was forecast?

DR. FLYVBJERG: Correct.

MR. SIMMONS: Okay. So if you follow along the 1 line there, there are quite a few dots on that chart which are below 1, and they seem to be fairly evenly distributed throughout the timespan that's covered by the chart.

DR. FLYVBJERG: Yes.

MR. SIMMONS: Okay.

So for those, are those indications that those projects represented by those dots came in either on budget or below budget?

DR. FLYVBJERG: Correct.

MR. SIMMONS: Okay.

Now, I understand that your evidence about root causes has been that you've eliminated the kind of direct factors that are typically relied upon, and you have said that optimism, bias and political bias are the best explainers of the reasons for cost overruns.

So am I correct that, when you say that, you are looking at megaprojects in the aggregate, to say that on an aggregate basis they are the best explanations of cost and schedule overrun?

DR. FLYVBJERG: Yes, that is correct. And I wouldn't say we have eliminated the other explanations. We just say that they are intermediary explanations. They are not the root explanations.

MR. SIMMONS: Yeah. So when I look at your chart there for cost, and I see that there are a fair number of projects that came in on budget or below budget, do we assume from that that there would have been no problems with optimism bias or political bias with those projects? Is that an inference that we make?

DR. FLYVBJERG: That's a possible inference; but, like I mentioned earlier, we actually have special studies where we look at projects like that to find out, you know, what are the real reasons that they were successful in this manner? Were they just lucky, or did they have a sound methodology to arrive at those results?

MR. SIMMONS: Right.

And you've mentioned a couple of times in your evidence that in some cases you've done systemic study of factors such as your statistical review of megaprojects. In other areas where you've given us comment in responses from questions from Mr. Learmonth you said there hasn't been any systematic review but you've been able to offer some view on it.

So has there been any systematic review done of what it is about those projects that have been on budget that has caused them to be successful?

DR. FLYVBJERG: Do you mean the specific products in this diagram?

MR. SIMMONS: Well, these represent the megaprojects that are included in your database, don't they?

DR. FLYVBJERG: Exactly. So these are the hydroelectric dams only.

MR. SIMMONS: Oh, okay.

DR. FLYVBJERG: So these ones in this diagram are only hydroelectric dams.

MR. SIMMONS: Yes.

DR. FLYVBJERG: And the answer is, no, there is no systematic study by us or by anybody else that I know of that have studied the hydroelectric dams that are on budget or below budget.

MR. SIMMONS: Right. Right.

So can we conclude anything then about whether optimism bias or political bias was present in any of those projects? And if it was either not present, why it was not present, or, if it was, whether it was counteracted by some other mitigating activities?

DR. FLYVBJERG: No, I wouldn't feel comfortable speculating about that without studying the actual projects.

MR. SIMMONS: Mm-hmm. Right.

But nevertheless, we do know there have been successful projects.

DR. FLYVBJERG: Yes.

MR. SIMMONS: Right.

I'd like to go to page 22 of the report, please. And just scroll up a little bit. Okay, you can stop there, please.

This is the chart, the probability chart that you referred to earlier in your evidence. And it shows an s curve, I'll describe it, and three different levels of P values, or probability values, P30, P50, P80 that you've matched to three different – I don't know if you'd call them activities or features of typical major megaprojects.

And if I recall your evidence, you've said that the higher level of certainty around controlling risk at the P80 level should be used at the owner's level, where the owner is, I presume, making the decision whether to proceed with a project or not.

DR. FLYVBJERG: Correct.

MR. SIMMONS: Okay.

And then the intermediate level you've described as being – the P50 level as being “Most likely estimate allocated to projects based on portfolio management approach.” And the lower level, P30, is the “estimate allocated to contractors with pain/gain-sharing agreement.”

Can you tell me a bit more, in a practical way, how these different P levels would be used in the life of a megaproject to manage the decision to carry out the project and to control the risks and keep the cost as low as possible to the project?

DR. FLYVBJERG: So the first thing you can use them for is to, you know, figure out, can we actually afford this project.

MR. SIMMONS: Mm-hmm.

DR. FLYVBJERG: Do we have the funds to cover the base cost of the product? Do we have the funds to set aside the contingency? So that's the first thing you can use them for, to get a

realistic view of what will this actually cost us total. And also a realistic view, what are the risks that it would – would it cost even more or cost less? You know, so both sides. It would also help you with getting an idea of that at the outset.

And then once you start delivery, if you decide to go ahead with the project, you know, the contingency would be there at the outset. And as things happen with the project, most likely some of that contingency would be drawn down and spent on the project. So the contingency will be smaller, and you revise your contingency as you go along.

You wouldn't necessarily – and you wouldn't keep the same contingency throughout the whole project delivery period. Let's say you didn't draw down on your contingency and you've now built 60 per cent of the project, there'll be no need for having the whole contingency sitting there anymore, so you'd revise it.

So it's a dynamic process. And basically, what you see here is a picture of how you'd structure it at the outset, the fund and the business case that we talked about earlier. And then you'd have to revise that dynamically as you go along, depending on whether or not and how much you draw down of the contingency.

MR. SIMMONS: Okay.

So do I understand correctly that your suggestion is that a probability of a cost overrun assessment at the P80 level – and I think in your evidence you said it could range around that.

DR. FLYVBJERG: Yeah.

MR. SIMMONS: It could be somewhat less, it could be somewhat more, depending on the project. That probability – the purpose of assigning that and quantifying it would be for the decision making to do the project or not.

DR. FLYVBJERG: Yeah.

MR. SIMMONS: Is that right?

The lower level you have there, which you have there as the P50 level, is that what you use to quantify a value of contingency that you then

assign to the people in the organization that's building the project to say: you have to work within this contingency? This is how much money you have available for overruns but no more.

DR. FLYVBJERG: Correct. That is the idea in this illustration. Yes.

MR. SIMMONS: Right. So the people who are building the project, do they know about how much – about what the value of the P80 level is – that it's been evaluated? I'm just trying to understand –

DR. FLYVBJERG: Yeah.

MR. SIMMONS: – how this actually works –

DR. FLYVBJERG: Yes.

MR. SIMMONS: – in real life.

DR. FLYVBJERG: So typically, they would know. If it's a government project, yes –

MR. SIMMONS: Yes.

DR. FLYVBJERG: – most likely, they would know.

MR. SIMMONS: Yes.

DR. FLYVBJERG: If it's a private business project, I know examples where they don't know –

MR. SIMMONS: Mm-hmm.

DR. FLYVBJERG: – or they didn't know.

MR. SIMMONS: Mm-hmm.

DR. FLYVBJERG: So they all depends on the organization. But I would say, in the public sector, it'll be difficult to keep contingency a secret.

MR. SIMMONS: Why would – in the private sector, why would it not be known? The – why would the decision-making level of contingency not be known to the people assigned the responsibility of building the project?

DR. FLYVBJERG: In the private sectors?

MR. SIMMONS: Yeah.

DR. FLYVBJERG: It just might be that, you know, the owner or the CEO of the company decides that that's not a good idea; that they know that they prefer at the C-suite level or the board level to keep that as their information that they have sort of an emergency pool of money that they can step in with and they know that they need to have that in order to ensure that the organization has the funds to actually build the project.

MR. SIMMONS: Mm-hmm.

DR. FLYVBJERG: But they might find that, one, they don't want to go through all the hassle of having to explain that to the rest of the organization. They don't want – they may be – they are afraid of the red-meat syndrome that we talked –

MR. SIMMONS: Mm-hmm.

DR. FLYVBJERG: – about earlier, that if it's known that the money is there, they would be subject to more pressure for actually giving out the money.

MR. SIMMONS: Mm-hmm.

DR. FLYVBJERG: So those should be some of the concerns regarding that.

MR. SIMMONS: Okay. And then the lower level there, the P30 level, is the estimate allocated to contractors? So that is a – do I – am I correct in thinking that this is a – some lower level of contingency that contractors may be aware of, or is it a lower-level of contingency that those who are doing the tendering and awarding the contractors are aware of? How does that level of –

DR. FLYVBJERG: So –

MR. SIMMONS: – contingency reserve –

DR. FLYVBJERG: – the intention –

MR. SIMMONS: – work?

DR. FLYVBJERG: And again, this is an illustrative example, and as you rightly pointed out earlier, these are illustrative values and there's flexibility in how –

MR. SIMMONS: Yes.

DR. FLYVBJERG: – you set them. But, yes, that is the idea here that the contractors would have the P30 project including the P30 contingency and incentives would pain gain as we say here.

MR. SIMMONS: Yeah.

DR. FLYVBJERG: Pain-gain structures have been set up that the contractors are actually incentivized to deliver to that budget, and they will make extra money if they do it; they will lose money if they don't.

MR. SIMMONS: Hmm. Okay. Can you give any – in the projects you've seen, can you give us an example of what this kind of pain-gain arrangement would be with a contractor?

DR. FLYVBJERG: Yes. So Terminal 5 at the London Heathrow –

MR. SIMMONS: Mm-hmm.

DR. FLYVBJERG: – Airport is a famous example of that – that they created a pain/gain structure for the contractors. So the contingencies were actually in that pool, and if the contingencies weren't used, there was – like, normally, the contingency just stays with the owner.

MR. SIMMONS: Mm-hmm.

DR. FLYVBJERG: Here, the contingency was shared between the owner and the contractors if it wasn't used. So the contractor had an incentive to not use it, in the sense that they would then get a pure profit from the contingency –

MR. SIMMONS: Mm-hmm.

DR. FLYVBJERG: – instead of just losing it.

MR. SIMMONS: Right. So the contractor would be aware that if the contractor comes in

under budget, that all the savings do not go to the owner, the contractor will share in it, so there's an incentive to do that.

DR. FLYVBJERG: They would be very well aware that that would be written down, you know, that would be part –

MR. SIMMONS: Yes.

DR. FLYVBJERG: – of the contract that they signed, actually.

MR. SIMMONS: Yes. Yes. And your view is that that is an appropriate way to approach contracting and megaprojects?

DR. FLYVBJERG: It is. It takes a mature proponent or owner –

MR. SIMMONS: Mm-hmm.

DR. FLYVBJERG: – if you wish, to manage things like that. But, yeah, for mature owners, it's a good idea.

MR. SIMMONS: Okay. So to look back at the S-curve again – so, at the time P50 level, this – based on a P50 estimate of the risk of exceeding budget, those who are charged with the responsibility of building the project have a value of contingency available to work with. And the contractors, though, have a smaller contingency to work with. So are the contractors in this kind of arrangement aware of how much the higher contingency is that the – that those building the project have available to them?

DR. FLYVBJERG: Typically not.

MR. SIMMONS: Mm-hmm. Why would that be that? Why wouldn't they be aware?

DR. FLYVBJERG: Well, you know, many owners don't think that's something that's relevant information to contractors. They would prefer to keep it away from the contractors, so that – this is really about the owner's appetite for risk and that's not necessarily a relevant piece of information for the contractors – seen from the owner's point of view.

MR. SIMMONS: Mm-hmm.

DR. FLYVBJERG: Why should they care about what happens?

MR. SIMMONS: Hmm.

DR. FLYVBJERG: If I'm very conservative and I put aside a big a contingency –

MR. SIMMONS: Mm-hmm.

DR. FLYVBJERG: – why would I want the contractors to know that?

MR. SIMMONS: Mm-hmm.

DR. FLYVBJERG: If I'm not conservative, I put aside a smaller contingency. Why would I want them to know that? They should know their contingency, and that's what they should focus on –

MR. SIMMONS: Hmm.

DR. FLYVBJERG: – and then maybe have this incentive structure that will –

MR. SIMMONS: Mm-hmm.

DR. FLYVBJERG: – give them pain or gain.

MR. SIMMONS: In a case where there's tenders called and there are competitive bids for contract work on a megaproject, is that a case where you would normally expect that contractors who are submitting tenders would not be aware of what the owner's budget was for their work or of how much contingency the owner was considering was appropriate for their work?

DR. FLYVBJERG: They will often have an idea of what the estimate is. Like, the owner is working with some kind of estimate before the tendering process.

MR. SIMMONS: Mm-hmm.

DR. FLYVBJERG: And typically the contractors would know that. They might not know the details of contingencies and so on.

MR. SIMMONS: Mm-hmm.

DR. FLYVBJERG: They might have an idea whether there's a contingency or not, maybe a ballpark figure, but typically not detail. But this is a general statement, you know, projects are very different, so it can be different from project to project.

MR. SIMMONS: Yes, yeah. Would I be correct in thinking that if there was a large pool of potential contractors who were bidding competitively, very competitively against each other, there's less concern if they were aware, generally, of the budget was than if it's a relatively limited pool of contractors who are capable of doing the work?

DR. FLYVBJERG: I would say –

MR. SIMMONS: (Inaudible.)

DR. FLYVBJERG: – yes, that's correct.

MR. SIMMONS: Okay.

THE COMMISSIONER: Five more minutes, Mr. Simmons.

MR. SIMMONS: Thank you.

I had a couple questions for you about your experience with actual implementation of reference class forecasting. You've given us, I think, three examples that you're aware of around the world where it's been implemented on a – some sort of programmatic basis. One being the – in the United Kingdom by the transportation department of government. Another one being in Norway, and another one in Hong Kong.

DR. FLYVBJERG: Not Norway.

MR. SIMMONS: Oh, I'm sorry.

DR. FLYVBJERG: Denmark.

MR. SIMMONS: Oh, in Denmark.

DR. FLYVBJERG: Yeah.

MR. SIMMONS: My apologies.

DR. FLYVBJERG: No problem.

MR. SIMMONS: So – and of those three, is the UK experience the one that's been in place for the longest and where there's the most experience?

DR. FLYVBJERG: Yes, it is.

MR. SIMMONS: Yeah. And if I understand correctly, there's a fairly low threshold for value of project that it applies to – £5 million and up for transportation projects?

DR. FLYVBJERG: Correct.

MR. SIMMONS: Which would be like road projects, highway overpasses, that sort of thing.

Has it been challenging developing a set of reference cases for projects of that type and that scale?

DR. FLYVBJERG: No.

MR. SIMMONS: No. Okay.

In Hong Kong do you know what type of projects it's being applied to?

DR. FLYVBJERG: Yes.

MR. SIMMONS: What sort of projects are those?

DR. FLYVBJERG: The first type of project work was roads. It's been applied to rail. It's been –

MR. SIMMONS: To rail?

DR. FLYVBJERG: Rail projects –

MR. SIMMONS: Yes.

DR. FLYVBJERG: – yes. It's been applied to sewage projects –

MR. SIMMONS: Mmm.

DR. FLYVBJERG: – to architectural development – so schools, public buildings and so on.

MR. SIMMONS: Right.

DR. FLYVBJERG: Basically the Hong Kong government has decided to roll it out across all government departments.

MR. SIMMONS: Okay. And in Denmark, do you know what type of projects it's been applied to –

DR. FLYVBJERG: Transport.

MR. SIMMONS: – or class of projects.

DR. FLYVBJERG: Transport infrastructure projects.

MR. SIMMONS: Transport.

DR. FLYVBJERG: Yeah.

MR. SIMMONS: So most of those examples, are those types of infrastructure work where – I won't say it's repetitive, repeat work over and over, but there are ready classes of projects from which you can find some similarities. Two highway overpasses may not be the same, but they have some similarities in the type of work that has to be done.

DR. FLYVBJERG: Correct.

MR. SIMMONS: Yeah, okay.

When you take – and are you aware of reference class forecasts in being applied to hydroelectric development projects?

DR. FLYVBJERG: Not off the top of my head, no.

MR. SIMMONS: Right. Okay.

Have you aware whether it's been assessed for the relative ease or difficulty of applying it to a hydroelectric project?

DR. FLYVBJERG: No.

I'm – not that I'm aware of.

MR. SIMMONS: Okay, all right.

Can you offer any view on whether it would be just as easy to get a reference class of projects for a hydroelectric development as it would be

for the other areas where it's been implemented in Denmark, UK and Hong Kong?

DR. FLYVBJERG: Yes.

I can say that it would be just as easy. We have – compared to other asset classes that we cover – we have very good data for all hydroelectric so it would be fairly easy and it would not be – take a long time, it would not be very expensive to do. It's something that could be done easily and fast.

MR. SIMMONS: Okay.

DR. FLYVBJERG: And cheap.

MR. SIMMONS: Okay.

Do you know of any reason why we haven't seen it implemented and used for hydroelectric projects?

DR. FLYVBJERG: No I don't, and also I have to say that I don't know that it hasn't been used; it might have been used, of course, without me knowing it.

MR. SIMMONS: Okay.

I had a couple questions for you about the outside view. The reference class forecasting I think is one way to provide an outside view that you've described, yes?

DR. FLYVBJERG: Correct.

MR. SIMMONS: And two others that you've identified are independent reviews and peer reviews.

DR. FLYVBJERG: Mm-hmm.

MS. SIMMONS: So, for peer reviews first, peer reviews I understand to be conducted within an organization but using people not directly involved in the particular project.

DR. FLYVBJERG: Correct. Your peers.

MR. SIMMONS: Yes.

Can you tell me, do you see advantages and disadvantages to using peer reviews and maybe could you identify some for me please?

DR. FLYVBJERG: So I will say advantages is that it's easier and it's friendlier, you know, and it's less formal than having a full, you know, independent, outside review by experts and yeah. So that's – those are the advantages. The disadvantages could be if you were in an organization that has some kind of tunnel vision, you know, or groupthink, which has been known to happen in organizations. Then the peers might suffer from the same kind of groupthink or bias that we talk about so it wouldn't be an unbiased outside view.

MR. SIMMONS: Yeah. Can you give us some idea of how prevalent or not peer review processes are in these industries for providing an outside view?

DR. FLYVBJERG: So I wouldn't be able to talk about industries in general. This is something that we have seen develop within the UK government as we've developed the MPLA, the Major Projects Leadership Academy for the UK government, and implementing that. And it's prevalent in the UK now –

MR. SIMMONS: Mm-hmm.

DR. FLYVBJERG: – in UK government.

MR. SIMMONS: Yes.

So, even though the UK government has adopted, in some areas, the reference class forecasting, it also recognizes peer review as being an appropriate means of bringing an outside view.

DR. FLYVBJERG: Absolutely.

This is – we are talking about a whole toolbox of things that need to be done.

MR. SIMMONS: Yes.

DR. FLYVBJERG: It's not just – one thing won't fix everything here, so we need to do different things.

MR. SIMMONS: Yeah.

So the independent reviews, then, are not peer, because they involve people from outside the organization, do they?

DR. FLYVBJERG: Correct.

MR. SIMMONS: Okay.

What kind of standards or criteria would be appropriate in the selection of people to come in from the outside and do a review of a megaproject?

DR. FLYVBJERG: That they are – first of all, of course that they are competent – that they know about the field, and then second, that they truly are independent. 'Cause otherwise they wouldn't be able to give their independent –

MR. SIMMONS: Yes.

DR. FLYVBJERG: – review of the project or program.

MR. SIMMONS: Yeah. Yeah. Okay.

So competence – and would experience in the particular field or area that's –

DR. FLYVBJERG: Yeah.

MR. SIMMONS: – that the project is being constructed in count? Okay.

And you've told us that there's a relatively limited pool of really good, competent people to build megaprojects out there. What's your view on the availability of good, qualified people to come in and do independent reviews on a megaproject-like hydroelectric project?

DR. FLYVBJERG: I think there are probably more people that can do the reviews than the master builders who are really accomplished in –

MR. SIMMONS: Mm-hmm.

DR. FLYVBJERG: – delivering megaprojects on budget and on schedule.

So there's a group of people and – like I mentioned earlier, I actually – I worked with national audit offices in several countries –

MR. SIMMONS: Yes.

DR. FLYVBJERG: – including in the UK, in the US, Denmark, Sweden, and maybe some I've forgot.

And I – even though none of the people in the national audit office have any experience in actually delivering a megaproject, they do have actual experience in analyzing numbers and seeing whether things are performing –

MR. SIMMONS: Mm-hmm.

DR. FLYVBJERG: – as promised, you know, in business cases and so on.

So I would consider – these institutions are actually good for doing these types of independent reviews.

MR. SIMMONS: Okay. Right.

So actual, hands-on experience building a major project isn't necessarily essential. People with other sets of useful skills can fulfill the same function.

DR. FLYVBJERG: Yes.

MR. SIMMONS: Yes.

DR. FLYVBJERG: I mean, it would always be a huge asset to have somebody with the actual hands-on experience. Unfortunately, they mostly have better things to do than review projects, you know, so ...

Like, they're in high demand being out there building them.

THE COMMISSIONER: So, Mr. Simmons –

MR. SIMMONS: Yeah.

THE COMMISSIONER: – I'm gonna have to ask you – if you have one more question, you can put it to him, and then I'm gonna have to move on.

MR. SIMMONS: I'll have to select which one it's going to be.

THE COMMISSIONER: Okay.

MR. SIMMONS: You were asked some questions by Mr. Learmonth concerning what the effect is of sovereign guarantees on large megaprojects. And I understood your evidence to be that while a guarantee may be beneficial in allowing a lower interest rate to be obtained on a project, that you saw it having – what I understood you to say was – a negative effect on how much attention was paid to assessing risk on a project because outside investors weren't as concerned about what the risk would be. Now you're nodding your head – have I summarized –

DR. FLYVBJERG: Correct.

MR. SIMMONS: – this correctly?

DR. FLYVBJERG: Correct.

MR. SIMMONS: And my question is, is that an observation from – that you've made based on projects you've looked at or has there been any kind of systematic evaluation done to test whether that is actually an effect of sovereign guarantees?

DR. FLYVBJERG: A small systematic evaluation that we did years ago – we're doing another study now where we're trying to get to this again. But yes, the answer is yes – a small study is systematic with statistical tests and everything that show that actually sovereign guarantees didn't perform well.

MR. SIMMONS: Didn't perform well?

DR. FLYVBJERG: Yeah.

MR. SIMMONS: Uh –

DR. FLYVBJERG: – compared to other setups, you know – other setups for finance.

MR. SIMMONS: Okay.

'Cause this suggestion was that the full benefit of a sovereign guarantee might be eliminated by the effect on how well risks were controlled. Has there been any research done that's validated that proposition?

DR. FLYVBJERG: Well that's part of the study that I'm talking about here and that's one

of the hypotheses – is that that is the reason that projects that were financed with sovereign guarantees didn't perform as well as projects that were not.

MR. SIMMONS: Yes. And when was that study done?

DR. FLYVBJERG: Two thousand and something. Like in the 2000s –

MR. SIMMONS: Yes.

DR. FLYVBJERG: Between two thousand and three or four and 2010.

MR. SIMMONS: Right, so that's – and that's one you were involved in is it?

DR. FLYVBJERG: Yes.

MR. SIMMONS: And so we can find the published reference to that –

DR. FLYVBJERG: Yes.

MR. SIMMONS: – if we do some research?

DR. FLYVBJERG: Yes.

MR. SIMMONS: Okay.

I'm out of questions.

THE COMMISSIONER: Thank you very much.

MR. SIMMONS: Okay, thank you.

THE COMMISSIONER: Concerned Citizens Coalition.

MR. BUDDEN: Good day Professor Flyvbjerg. I'm – my name is Geoff Budden. I represent the Concerned Citizens Coalition, which is a not-for-profit corporation, which has been founded by Newfoundland and Labradorians who are concerned about the – and for many years have been concerned about the economic, and social and environmental impact of this proposed development.

I have some questions for you. I'll be referring – for the benefit of the clerk – to Exhibits P-00004 and then, later, P-00134.

Perhaps, Professor, you could turn to page 6 of P-00004 which is your report. Looking at the footnote to that page, Professor, you – I'd ask you, I guess, firstly: Does your project analysis – do your project analyses include the transmission lines necessary to bring the hydroelectric dam power to market?

DR. FLYVBJERG: Yes.

MR. BUDDEN: Okay.

If we could turn to page 10, same exhibit, I note that the transmission cost that you have included on the table there, the fifth item down I believe, you have a cost overrun – a mean cost overrun in that instance of 8 per cent. That would be, I assume, for stand-alone transmission projects?

DR. FLYVBJERG: Correct.

MR. BUDDEN: Okay.

Then, if we flip back to that same footnote on page 6, you reference that the – and on the very end of that footnote that the main source of overrun in a hydroelectric project is the dam itself.

DR. FLYVBJERG: Correct.

MR. BUDDEN: Okay.

In the projects you looked at, what typically would be the breakdown within the project of the cost related to the transmission segment of the hydroelectric project vis-à-vis the other segments, particularly the dam construction and power station construction?

DR. FLYVBJERG: So I wouldn't be able to give you that number off the top of my head, but I would be able to say that it's a significant amount.

MR. BUDDEN: Okay. Would it be 10 per cent, perhaps, a little more?

DR. FLYVBJERG: I don't want to guess a number.

MR. BUDDEN: Sure.

DR. FLYVBJERG: But it's significant.

MR. BUDDEN: Okay.

If – would it follow, Professor, that if the Muskrat Falls Project consisted of a relatively higher percentage of transmission relative to the project cost as a whole, to bring the power to market from here in Labrador to a point south, that – and the median cost overrun of projects as a whole is 32 per cent, might the transmission cost segment of that which, from other of your studies would appear to be lower in the range of 8 per cent, would that perhaps not make the comparison a little more flattering to Muskrat Falls than it otherwise would be?

DR. FLYVBJERG: That would be impossible to say without looking at the exact numbers for Muskrat Falls, but then you would be able to say once you know the numbers. But I don't know the numbers for Muskrat Falls because I wasn't asked to study Muskrat Falls.

MR. BUDDEN: Oh sure. But just as a general principle you would confirm that if Muskrat Falls, say, had 35 per cent of the project was related to transmission lines, while in a typical project might only be 17 per cent, then in that instance the 32 per cent median cost overrun would be – if Muskrat ran that number, it would be perhaps not truly representative of the cost overrun at Muskrat Falls.

DR. FLYVBJERG: Well, I mean, the problem there is that you compare a group of projects with one project and you'd really have to look at that individual project to see what the exact costs are for that.

I understand where you're going. On average what you're saying would be right, but then I would – when I say on average it means that I'm not talking about just one project. But if I had a group of projects where, what you say, apply it to that whole group of projects and then I compared them to the projects that we have here in the table, then you would be right on average, yes.

MR. BUDDEN: Okay. Thank you.

DR. FLYVBJERG: But I wouldn't be able to say it for a singular project because we don't have any average for a singular project, right?

MR. BUDDEN: Of course, and maybe other witnesses will give us that information.

DR. FLYVBJERG: Yeah.

MR. BUDDEN: Perhaps you could turn to page 16 of the same exhibit.

I note there that you – and I quote the sentence which is four or five lines down: "Once higher-quality data was established that could be consistently compared across projects in numbers high enough to establish ... significance, explanations in terms of bad luck or error collapsed."

Are you referring to the higher data of this study or of a more generalized sense, as you discussed with earlier witnesses, of the field of academic work that you fall within?

DR. FLYVBJERG: The latter, so the more generalized studies that we'd done in the academic field. This is something that happened years ago when we came out with our first statistically significant study. We could see that this doesn't hold up so that's when this happened.

MR. BUDDEN: Okay, so you say years ago. Can you be a little more specific than that, 20 years ago perhaps?

DR. FLYVBJERG: More like 15 years ago.

MR. BUDDEN: Okay.

Would you agree that benefit underperformance is a key consideration for the ultimate evaluation of the success or failure of a hydroelectric project development?

DR. FLYVBJERG: Yes.

MR. BUDDEN: Okay, but that obviously didn't fall within the sphere of your particular study.

DR. FLYVBJERG: Correct.

MR. BUDDEN: Okay.

At page 17 of your report, perhaps to turn the page, you say – and I quote from well down the page: “... *the problem is not even cost overrun, it is cost underestimation.*”

Would you agree, Professor, that perhaps is the key finding or the key conclusion of your report as a whole?

DR. FLYVBJERG: I’m not sure I understand the question.

MR. BUDDEN: Okay.

DR. FLYVBJERG: So, like, is the conclusion of this whole report. No, I think there are many more conclusions. It’s a –

MR. BUDDEN: Okay.

DR. FLYVBJERG: – very important conclusion and it’s something people really need to grasp if they want to solve the problem –

MR. BUDDEN: Okay.

DR. FLYVBJERG: – of cost overrun.

MR. BUDDEN: So certainly here –

DR. FLYVBJERG: So it’s a key conclusion but there are many other important conclusions in this report, in my view.

MR. BUDDEN: Okay, but it is certainly a very important one?

DR. FLYVBJERG: Yes.

MR. BUDDEN: Okay.

At page 28 of your report, same report – and I’m looking at the paragraph just before 4.2.3 – you – and I quote: “Project reviews and audits can surface potential political bias in projects, e.g. the suppression of bad news. For reviews to effectively provide checks and balances, the reviews and audits need to be independent, i.e. free of political bias themselves. At a minimum, this requires reviews to be independent of any government agency overseeing a project” – and you give an example, reviews by the national auditor – “if not independent from government altogether.”

Professor, you obviously are familiar with the concept of public utility boards?

DR. FLYVBJERG: Yes.

MR. BUDDEN: Okay.

Might a public utility board serve such a function?

DR. FLYVBJERG: So, whereas I’m familiar with the concept of public utility boards in general, I’m not familiar with the, you know, peculiarities of Canadian public utility boards. So you’d have to give me more information to answer that question.

MR. BUDDEN: Okay.

If, for instance, a public utility board had the authority to review a project before sanction, such as the project we are currently considering, would that be the kind of review that you would regard as satisfying this criteria?

DR. FLYVBJERG: Who is on the public utility board?

MR. BUDDEN: We may be going down a path that we don’t need to go down into too great detail, but the typical model in Newfoundland is that it’s a government-appointed board, but with experts in the field who are independent in their operations on the board.

DR. FLYVBJERG: Okay. I feel I don’t know enough about the specific set-up here to be able to really answer that question.

MR. BUDDEN: Okay.

So what kind of agencies might one have, other than the national auditor?

DR. FLYVBJERG: In other areas – for instance, assessing environmental issues – some projects have used the set-up where they took leading independent experts from around the world and created an environmental review panel that would come in and review the project, actually on a regular basis, not just once, you know, but let’s say, every six months, every 12 months.

And these would be people with, you know, independent reputation, independent careers and so on. And they come from, you know, different countries so they would be at quite, you know, one or more arm's length from the project. So that's another set-up that has been used successfully –

MR. BUDDEN: Mmm.

DR. FLYVBJERG: – and successfully in the eyes both of the project owner and the corporation delivering the project and of the expert group.

MR. BUDDEN: Okay.

So if such a board or a panel were struck and delivered a report, what kind of consideration would you expect such a report to be given?

DR. FLYVBJERG: I would expect it to be given serious consideration. And I would expect there to be a set-up where it would have to be given serious consideration according to the rules that is regulating what's happening with the project.

MR. BUDDEN: At page 25 of the same report, you make a reference to good project leaders. You say specifically: Good project leaders know how to put in place realistic contingencies. From your review, can you give an example or two of such good project leaders of particular projects that, in your view, were blessed with good project leaders?

DR. FLYVBJERG: Yup.

The Crossrail project in London is an example. They actually used reference class forecasting and up front, at the very beginning, and estimated their contingency on that basis. And it's pretty much held up. There's been a small cost overrun. It's actually in *The Financial Times* today and – but it's much smaller than what you've seen on other projects.

The Madrid Metro – so the Metro in Madrid in Spain is another example. They had a very experienced leader who directed several lines, additional lines to the Metro; the biggest expansion in its history. And the same thing happened that they – that he actually wouldn't

start without a certain contingency that he knew was necessary from his experience.

MR. BUDDEN: Okay.

DR. FLYVBJERG: And he got that contingency and he managed it rigorously, without the red-meat syndrome kicking in.

MR. BUDDEN: Sure.

Are you aware of any –?

DR. FLYVBJERG: So it's possible –

MR. BUDDEN: Apologize – are you aware of any examples from the hydroelectric megaproject field?

DR. FLYVBJERG: No, but that doesn't mean that they don't exist. I haven't been looking systematically for them –

MR. BUDDEN: Sure.

DR. FLYVBJERG: –in that field.

MR. BUDDEN: And I think just to repeat, make sure I understand, when you were asked about reference class forecasting in the hydroelectric field, I believe your answer was you're not aware of it being used, but you can't eliminate the possibility because there are projects, obviously, you are not privy to their details?

DR. FLYVBJERG: Correct.

MR. BUDDEN: Okay.

Are you aware of any projects in your study that were specifically, by decision of the authorities for that jurisdiction, removed from the overview of a statutory board or of a joint review panel, such as the kind we discussed a few moments ago, or of an auditor general?

DR. FLYVBJERG: Are you talking about the dams in the study?

MR. BUDDEN: I am talking about the – well, let's talk about the dams first.

DR. FLYVBJERG: Yeah. No, I'm not aware of that. We haven't looked for that, so I'm not surprised that we haven't found that. So it's not something we've been looking for.

MR. BUDDEN: Okay. And although you have not specifically looked for it, in the research you have done you haven't found it?

DR. FLYVBJERG: We didn't look for it, so that's why we didn't find it. I'm not saying that it's not worth looking for, I do, but there's – you know, there's a limit to how many studies one research group can do and that's all.

MR. BUDDEN: Fair enough. The – you're familiar with the concept of a Crown corporation, I assume?

DR. FLYVBJERG: Yes.

MR. BUDDEN: Are you familiar as well with, or did your study include other hydroelectric projects that were completed by Crown corporations?

DR. FLYVBJERG: I'd say that I'm pretty sure that it does include such but, again, this is not something we had focused on. Our dam study is really a statistical study where we don't – we have a few examples of a very large cost overrun where we actually mention the name of the dam and what happened, and we – you know, some of the dams I did find names, the debt has been a problem for the country that they are located in, but that's all. Basically, it's really a large-number study where we don't pay much attention to the individual dam as yet.

And, again, I want to emphasize, that doesn't mean that we wouldn't learn a lot by doing that; we just haven't had the capacity to do it yet.

MR. BUDDEN: Sure.

When did you, yourself, first publish this analysis or perhaps an earlier – well, I know there's been at least one earlier version or the – what is the earliest version of this megaproject cost overrun analysis and scheduling overrun analysis that you, yourself, have published?

DR. FLYVBJERG: So are we now talking about megaprojects in general, not just the dams?

MR. BUDDEN: Well, let's take it as two questions, megaprojects in general.

DR. FLYVBJERG: So for megaprojects in general in 2002, that was that study I talked about earlier, the first statistically significant study ever of large-scale projects like this. And for dams it's 2014. So we did a study that came out in 2014.

MR. BUDDEN: 2014.

DR. FLYVBJERG: For dams.

MR. BUDDEN: Perhaps you turn to page 12 of P-00004.

I apologize, Your Honour, just finding my right page.

I thought it was page 12 but apparently it's not. But it was the schematic that on the left-hand side you had the cost overrun and the right-hand side you had the schedule overrun and on (inaudible) that were the various dots representing your – the projects that you studied.

DR. FLYVBJERG: Page 8?

MR. BUDDEN: Page 8.

That's the one. Thank you.

I would presume that when we have further information – you obviously have not studied the Muskrat Fall because it's not part of what you were asked to do. But, at some point, with further information, we can follow your formula and place Muskrat Falls in each of these schematics, I would assume. You see no reason why that could not be done?

DR. FLYVBJERG: As long as the numbers are calculated the same ways, we use the same baseline, you don't include inflation, also these numbers do not include financing costs. So if you have financing costs included in the Muskrat Falls numbers that should be taken out. So you just need to make sure that you're comparing like with like.

MR. BUDDEN: Of course.

DR. FLYVBJERG: If you do that, then you can do – you can fit in Muskrat Falls with these diagrams and tables.

MR. BUDDEN: Okay. We need a podium with a deeper lip, I think.

I would now like to turn to your other document, which is P-00134, which is an article that you wrote some time before this study for this Commission. And you open with a, you know, with a rather striking quote about how you wouldn't ask a person with a driver's licence to fly a jumbo jet, et cetera, and – to illustrate your point about having appropriate expertise.

I would take that one – I would ask you if you would take that one step further and say that you wouldn't undertake a megaproject of the construction of a hydroelectric dam without the specific hydroelectric dam expertise as part of your project team. Would you agree or disagree with that assertion?

DR. FLYVBJERG: I would agree with that.

MR. BUDDEN: Okay.

Are you personally aware of any empirical evidence that relates the cost on schedule – the cost or schedule overruns of hydroelectric projects to the past megaproject experience of the project management team?

DR. FLYVBJERG: Sorry. When you say the project management team, I'm not sure what you mean.

MR. BUDDEN: I mean the team that is running the – that particular megaproject. Can you – are you aware of any empirical evidence – any studies – that relate cost overruns with scheduling overruns –

DR. FLYVBJERG: Okay.

MR. BUDDEN: – to the experience of that team? The megaproject experience.

DR. FLYVBJERG: Not statistically systematic studies like what we've been talking about here. But there are studies where we have singled out

individual master builders, as we call them, so megaproject leaders that have proved that they can deliver these projects. Not just once, but several times on several projects. They have a track record of being able to deliver successfully. So we have studied them.

But our point of departure was that we only chose the successful ones, and then we actually wanted to tease out what is it they do that make it successful. So that's how we've studied this. So it's not a correlation between the quality of the team or the performance; we actually only chose projects that had high performance that were successful for this particular study. And I'm not aware of other studies or other researchers around the world who would have done such a study.

MR. BUDDEN: Can you just briefly describe some of the characteristics those successful project leaders would've had?

DR. FLYVBJERG: Yeah. So first of all, they make sure they have a realistic business case at the outset. They have a very – a realistic picture of what it is that they're going to do, and they will not start on the basis of an inadequate business case. Many of them have actually tried that earlier in their careers and come to grief by doing it, you know, having their careers almost destroyed, or we actually have examples of people who had their careers destroyed because they signed up for a bad business case, and no matter how good they are – like I said earlier – you can't deliver it.

So one characteristic is a very keen eye on having a realistic front end, as we call it. So, like, the business case that you start out with. And then, second, that they are very aware of who they choose for their team. So they handpick the team that they're going to deliver with so to make sure that they get people like themselves who actually know what they are doing and have tried it before. Those are the two main things, basically, that they do.

MR. BUDDEN: So those people are out there and, for instance, in your consultation business, you'd be familiar with them. In your consultancy business, you can identify them?

DR. FLYVBJERG: Yes.

MR. BUDDEN: Okay.

Was the Churchill Falls – Upper Churchill hydroelectric project of the 1960s one of the 274 projects which forms part of your report? Or are you able to say with that kind of detail what was in your report?

DR. FLYVBJERG: I believe it's not.

MR. BUDDEN: Okay.

Are you familiar with the hydroelectric developments of Hydro-Québec in Quebec – in Northern Quebec?

DR. FLYVBJERG: No.

MR. BUDDEN: Okay.

So you're not coming here to speak to the experience of specific hydroelectric projects, so much as you are to speak to the general experience of projects?

DR. FLYVBJERG: That is correct.

MR. BUDDEN: Okay.

And I believe you just noted that – cost overruns, you're not including financing costs in your costs either before or after the project.

DR. FLYVBJERG: Correct.

MR. BUDDEN: Okay.

And this is perhaps covering some ground, but you're taking the sanction costs number – where it comes from, what you would regard as a reliable source – as a given, but in cases – other cases – you perhaps researched that in order to form the base of your study?

DR. FLYVBJERG: Could you repeat the last part?

MR. BUDDEN: Sure. In your evidence earlier today, if I understood you correctly, you were questioned as to how the project development, how the sanction cost was arrived at, and I believe in some instances you said you took it as a given if it came from a reputable government

agency, but in other cases you did some independent research?

DR. FLYVBJERG: Correct.

MR. BUDDEN: Okay.

DR. FLYVBJERG: Yeah. But even the numbers from the reputable government agency, we would check them, you know, we would test the numbers, and we don't accept anything at face value. We'd also always check, you know, whether the criteria that we know need to be fulfilled for the data to be valid, whether they are actually fulfilled.

MR. BUDDEN: Sure.

I'd like to go back now to your earlier exhibit. Just a half-dozen more questions. Page 21, if we could look at that. And I'm looking particularly on the discussion following "during the front end, when projects are appraised," and then one of the factors you identify is affordability.

What – perhaps could you tell us a little more what you mean by that in that context?

DR. FLYVBJERG: Basically whether the project owner has enough money to actually build the project, given the risks involved.

MR. BUDDEN: Okay.

In your study, were you able to come to any conclusions about by whom the cost overruns were ultimately borne? In these projects with the various cost overruns, could you discern a pattern?

DR. FLYVBJERG: Well, that varies a lot. So in government projects it's typically the taxpayer. Same thing with products with Crown organizations, where there's a sovereign or government guarantee behind, typically, the taxpayer. But we also have many examples of private sector projects where it's actually the private company itself that bears the cost of the shareholders. And the people who have lent money to the company are the ones that bear the cost overruns.

MR. BUDDEN: But in public sector it's the taxpayer?

DR. FLYVBJERG: Yeah.

MR. BUDDEN: Okay.

Going back to P-00134, the following page 12, you have an interesting discussion of Hirschman's hidden hand, that particular phenomena. Can you just briefly summarize for our benefit what you're saying there?

DR. FLYVBJERG: So Hirschman's Hiding Hand –

MR. BUDDEN: Hiding Hand, sorry.

DR. FLYVBJERG: – is a theory that Albert O. Hirschman, who was an American development economist who worked at Princeton Institute of Advanced Study, and where he theorized that it actually is not such a bad thing to start projects on the basis of two lower budgets and other types of inadequate information. Like, too optimistic about it, too optimistic a schedule. Because it actually has the function of getting things started, and that's a good thing according to him.

And he said that just as people underestimate the cost, they also underestimate the benefits. So it's not such a bad thing, because once you get things started, even though it's on the wrong basis, on basis of the wrong budget and the wrong schedule, once you get started you'll actually realize that you're going to be able to produce more benefits than you expected and they will be able to compensate for the higher cost that you're going to incur and for the delays that you're going to incur. That's the theory.

So, unfortunately, he based that theory on 11 projects that he'd hand picked around the world, and it's just way too small a sample to develop such a general theory on the basis of it. And so we tested it with more than 2,000 projects, and it turns out that it's completely wrong. In the sense that – it's correct that low cost and the optimistic schedule actually gets products started, but it's not correct that those projects are generating more benefits than expected. You see the exact opposite; 80 per cent of those projects are producing less benefits than they projected.

So they were optimistic about the cost and the benefits; whereas, Hirschman theorized that they

would be optimistic about the cost were pessimistic about the benefits. And he was wrong about being pessimistic about the benefits. So the theory just doesn't hold up when you test it with more data.

MR. BUDDEN: And also wrong about optimistic about the cost, it would appear.

DR. FLYVBJERG: Say again, please.

MR. BUDDEN: And also wrong about optimistic about the cost, it would appear.

DR. FLYVBJERG: Well, no. I mean, he was right that people are optimistic about the cost but it just didn't have – it wasn't evened out by the –

MR. BUDDEN: Yeah.

DR. FLYVBJERG: – by being pessimistic about the benefits.

MR. BUDDEN: Sure.

Finally – this may be my last question, subject to a quick look at my notes. In that same paper, following page 8, you speak of the four sublims thesis. And can you tell us a little bit about that?

DR. FLYVBJERG: Speak about what?

MR. BUDDEN: The four sublims. It – at page 8 of your thesis.

DR. FLYVBJERG: So we're still in exhibition 00134?

MR. BUDDEN: Yes, we are.

DR. FLYVBJERG: And which of the columns?

MR. BUDDEN: It's at page 8.

DR. FLYVBJERG: Yeah.

MR. BUDDEN: The headline is: "The Four Sublims."

DR. FLYVBJERG: Sublims – got it, yep.

MR. BUDDEN: Yeah. Can you tell us what the four sublims are?

DR. FLYVBJERG: Yes. So the four sublimes are – so there’s a political sublime that – you know, politicians like to start big projects. We see that as a pattern. And we theorized that it’s a – you know, as a politician it gives a good image that you’re proactive and get things done and it gets you in the media. With these big projects, often you have very important people to come and cut the ribbon.

So there are all sorts of advantages from a politician’s point of view of getting more visibility, which is what you need if you need to be re-elected. So that’s the political sublime.

MR. BUDDEN: Yeah. You put it very colourfully in your paper. Perhaps you could just read us the first sentence after your name appears on the right-hand side on page 8.

DR. FLYVBJERG: So –

MR. BUDDEN: Perhaps read that first sentence after your name appears on – under the four sublimes.

DR. FLYVBJERG: So is that the last paragraph on –

MR. BUDDEN: It is.

DR. FLYVBJERG: Okay:

“Flyvbjerg proposed three additional sublimes, beginning with the ‘political sublime,’ which here is understood to be the rapture politicians get from building monuments to themselves and for their causes. Megaprojects are manifest, garner attention, and lend an air of pro-activeness to their promoters; moreover, they are media magnets, which appeals to politicians who seem to enjoy few things better than the visibility they get from starting megaprojects, except, perhaps, the ceremonious ribbon-cutting during the opening of one in the company of royals or presidents, who are likely to be present, lured by the unique monumentality and historical import of many megaprojects. This is the type of public exposure that helps get politicians re-elected; so, therefore, they actually seek it out.”

MR. BUDDEN: Okay.

And would you agree, I guess, as a general conclusion of your paper, that the role of a good project manager, the role of public oversight is to prevent the four sublimes from getting out of hand and seeing projects commenced that really, perhaps, should not be commenced or at least not commenced in that way?

DR. FLYVBJERG: I believe it’s the role of good project planners and managers to eliminate the negative effects of the sublimes. So there’s nothing wrong with being happy about ribbon-cutting with the president, or the queen if it’s in the UK, but if that’s the driving force and everything else is set aside, then it can become a very negative thing. So that’s how I would see the role of the planners and managers.

MR. BUDDEN: Okay.

Thank you.

I have no more questions.

THE COMMISSIONER: Okay, thank you.

Edmund Martin.

MR. SMITH: Good afternoon, Sir.

I’m trying to get a timeline on the theory of the reference-class forecasting. I think you indicated to one of the lawyers present that there is a context of 2012 when it first – when this theory first came forward?

DR. FLYVBJERG: No. So the theory came forward a lot earlier than that, in the 1970s actually, in some of the Nobel Prize-winning work that Kahneman and Tversky did together. So that’s several decades ago.

Obviously, we took the idea and then developed it into a practical tool for policy and planning. And that happened in 2004.

MR. SMITH: Yeah.

DR. FLYVBJERG: It was published in – it started in 2003 and was published in 2004, to be precise.

MR. SMITH: So could you give us an indication from your research whether or not this approach of reference-class forecasting has been widely or moderately or scantily used?

DR. FLYVBJERG: I would say that it is being widely used and – but like I said earlier, it's not like a dominant methodology that is crowding out everything else, but I would say it's been and is being widely used.

MR. SMITH: Okay.

Now, if you excluded those areas where it's policy of government or legislation, is it still widely used? If you exclude where government has stepped in and said that it should be used.

DR. FLYVBJERG: So are you talking about the private sector now?

MR. SMITH: Well, there's a –

DR. FLYVBJERG: Oh, so just everything where it's not mandatory.

MR. SMITH: Right.

DR. FLYVBJERG: Is that what you're talking about?

MR. SMITH: Yes.

DR. FLYVBJERG: Okay, got it.

I would say that it's used quite frequently. I wouldn't say that it's widely used where it's not mandatory because it's not across the board, but it's being used often enough. I mean, people are seeing – intelligent forecasters are beginning to see, okay, this is actually something that can give us more equity. And if they are interested in equity, then they will start using it. So we see a lot of independent non-mandatory uses like that, yes.

MR. SMITH: Would you say that the use in 2017-18 would be greater than it would be in 2012-13?

DR. FLYVBJERG: Yes.

MR. SMITH: Okay.

So in 2012-13 there would be – it would be used in a non-compulsory fashion sometimes, but not frequently.

DR. FLYVBJERG: It would be used less frequently in 2012-13 compared to 2017-18.

MR. SMITH: Okay.

And if I look at the graph on page 8 of, I think it's your paper –

DR. FLYVBJERG: Is that Exhibit 00004 now?

MR. SMITH: Yeah, P-00004, I think it is.

DR. FLYVBJERG: Yeah, P-00004, page 8. Yeah.

MR. SMITH: Trying to understand, you know, the meaning of the blue line, if you would, that you have through both diagrams. Is that just the mean average or ...?

DR. FLYVBJERG: That's the trend line, so that's the trend of the observations there, so a best fit. And the mean average is used to make that fit, and so its variation around the average.

MR. SMITH: Okay.

And that appears that just as many – it seems just as many below the line as there is above. Yeah, a just general look, I didn't count the dots.

DR. FLYVBJERG: Yeah, I don't think that it's exact like that but – because some outliers will weigh more than others, but yeah, more or less.

MR. SMITH: Thank you, Sir.

That's all the questions I have.

THE COMMISSIONER: All right. Kathy Dunderdale.

MS. E. BEST: Good afternoon, Dr. Flyvbjerg. I'm Erin Best, counsel for Kathy Dunderdale.

You mentioned that you have acted as a consultant for some megaprojects. Is that right?

DR. FLYVBJERG: Correct.

MS. E. BEST: And I gather from that that one way to mitigate risk would be to hire an expert consultant like yourself.

DR. FLYVBJERG: Correct.

MS. E. BEST: Okay, now, you're not the only person out there who's doing this type of consulting in this area. Is that right?

DR. FLYVBJERG: Correct.

MS. E. BEST: Okay. And you've heard of Mr. Edward Merrow?

DR. FLYVBJERG: Yes.

MS. E. BEST: I think, actually, sometimes you cite his work and he cites yours. Is that right?

DR. FLYVBJERG: Yes, it is.

MS. E. BEST: Okay, so –

DR. FLYVBJERG: I know him well.

MS. E. BEST: Yes – sorry, you know him well?

DR. FLYVBJERG: Yeah.

MS. E. BEST: Okay. And you're both leaders in the field. Is that right?

DR. FLYVBJERG: I'm not the right person to judge myself; he's certainly a leader.

MS. E. BEST: He's a leader in the field.

DR. FLYVBJERG: Yeah.

MS. E. BEST: Okay.

And Edward Merrow is the founder and president of a consultancy group called IPA, Independent Project Analysis. Is that right?

DR. FLYVBJERG: Correct.

MS. E. BEST: Okay.

And they're a leader – an international leader in fact – in megaproject consulting. Is that right?

DR. FLYVBJERG: Correct.

MS. E. BEST: Okay.

So you described earlier your database of projects that you use for reference class forecasting. And IPA has a database, too. Are you aware of that?

DR. FLYVBJERG: Yes.

MS. E. BEST: I think they say on their web page that they have something like 18,000 projects, 600 megaprojects in their database. Does that sound right?

DR. FLYVBJERG: I haven't checked the numbers but I'm not questioning your number.

MS. E. BEST: Okay.

And these databases, this is what they're used for, is to do – one of the things they're used for is to do reference class forecasting. Is that right?

DR. FLYVBJERG: I'm not sure that they – whether they do reference class forecasting. They might have changed to that format, I don't know.

MS. E. BEST: Okay.

In general terms though, I guess, if you were an expert consultancy group for megaprojects and you had a database of many similar megaprojects, you would use that database to – oops – you'd use that database to compare to, I guess, take a look at and learn from similar megaprojects and then use that information to inform the project that you're consulting on. Is that right?

DR. FLYVBJERG: Correct.

MS. E. BEST: Okay.

So if the planners of a megaproject were to engage a consultant, either like yourself or like IPA, early on in the planning stages of the project, and then consult with them throughout the project, that would be a great way to mitigate project risk. Is that right?

DR. FLYVBJERG: Yeah, provided the consultants are good, they know what they're doing. Probably you wouldn't want to – with a

multi-billion dollar project, you might not want to use only one consultant but, like, try a couple and see how do their results compare.

And if they fit each other, you'll take that as an affirmation that they're on to the right thing. And if they don't, if they're very different, then you'll have to ask some questions about why is this, you know. But otherwise, yes, it would be a good idea.

MS. E. BEST: Okay, so using a consultant like IPA would be helpful?

DR. FLYVBJERG: Well, I'm not going to sit here and say use IPA. I'm not –

MS. E. BEST: Sure.

DR. FLYVBJERG: – also not going to sit here and say use me, you know.

MS. E. BEST: Right.

DR. FLYVBJERG: But the principle is right. That's what I'm saying.

MS. E. BEST: Right, so sorry, a consultancy group like IPA.

DR. FLYVBJERG: Yeah.

MS. E. BEST: Okay. Thanks. Okay.

I'm going to switch gears now. I wanted to ask about – you talked about the tiered contingency regime and how it can be beneficial to the project as a whole to share different information about P-risk factors and contingency amounts with different groups, right?

DR. FLYVBJERG: Correct.

MS. E. BEST: So to paraphrase that, can you just confirm for me that a tiered contingency regime would be an example of a situation where transparency should be limited.

DR. FLYVBJERG: Hmm.

MS. E. BEST: I mean to say if there's certain information that it's better to not share with some groups – as I think you've described, right,

as part of the tiered contingency regime – then you're limiting transparency, right?

DR. FLYVBJERG: I would say that, yeah. But I wouldn't be too concerned if there wasn't transparency because I've seen good project organizations and good project leaders actually being able to manage that situation. And it's pretty much – I would say that the incentive structures are much more important. But in principle you're right, yeah, you don't necessarily want to give out that information.

That might be the kind of thing you want to keep confidential as sensitive information because it could have – if somebody started to, you know, increase the prices of their bids for instance, it could have negative consequences. And if the contractors are talking to each other, if we don't have the situation that we talked about earlier where there's a large group of contractors that are in a real competitive situation with each other when it's not such a big concern, if we have a smaller group and they're not in a competitive situation, they talk to each other – even if there's a cartel, which we do find in some jurisdictions, it's quite normal – then you'd want to keep the information to yourself, yeah.

MS. E. BEST: Okay. Thank you.

Okay, switching gears again. I wanna go to the outside view or outside looks – you called it. So, Mr. Simmons asked you about – or brought up the issue of the federal loan guarantee and your sovereign guarantee study. So I just wanna expand on that a little bit.

So – and, excuse me, because I don't have a lot of familiarity with the sovereign guarantee study itself. But I'm wondering there: Were the same stakeholders involved? And what I mean by that is, in the case of this project, we have the federal loan guarantee, which is the federal government, which is quite a different stakeholder from the provincial government, right? So I'm wondering, in your study, if the stakeholders were more similar?

DR. FLYVBJERG: Do you mean the stakeholders on the different projects were similar to each other? Is that what you mean?

MS. E. BEST: No. I mean the stakeholders in terms of the federal government, in our case, versus the provincial government –

DR. FLYVBJERG: Okay.

MS. E. BEST: – who the – I guess the shareholders – I guess you could call them, the people, would be. They're quite different –

DR. FLYVBJERG: Yes.

MS. E. BEST: – right? The people of –

DR. FLYVBJERG: Yeah.

MS. E. BEST: – Canada versus the people of Newfoundland.

DR. FLYVBJERG: I understand that.

MS. E. BEST: What I'm getting at is I'm wondering if – because those people's interests are so different, that that might encourage the federal government to do more due diligence.

DR. FLYVBJERG: Right.

So in the study that I'm talking about, which, like I said, is a small study, mainly the national – or the government guarantee was from a national government. But, you know, in Europe, for instance, we don't have the federal set-up, so it would just be a national government that guaranteed – which would be equal to the federal government here, but not in the same kinds of set-up as you have with the federal set-up here.

MS. E. BEST: Okay.

In a situation, though, where – say, for example, then take the banks as potential funders, and you talked about how sometimes they can have a bias as well. But, aside from that, wouldn't they have – wouldn't the banks also have some incentive to do their own due diligence?

DR. FLYVBJERG: Well, that incentive would be limited if there's a government guarantee behind the project. They'll probably do some, but, you know, they're not at risk of losing their money. That's the real motivation for doing due diligence is that you might lose your money. If

you know you're not going to lose your money, that's a different situation.

MS. E. BEST: Okay.

So that takes me back to the sovereign guarantee then, because isn't the federal government at risk of losing the money?

DR. FLYVBJERG: Yes.

MS. E. BEST: Yes. Okay, so they would have some incentive to do their –

DR. FLYVBJERG: Yes.

MS. E. BEST: – own independent due diligence. Is that right?

DR. FLYVBJERG: Yes.

MS. E. BEST: And if they did in fact do that due diligence, and then shared it with the project manager, that would help to mitigate risk. Is that right?

DR. FLYVBJERG: Yes.

MS. E. BEST: Thank you.

Those are my questions.

THE COMMISSIONER: Thank you.

Former government officials, 2003-2016.

MR. T. WILLIAMS: Good afternoon, Professor.

DR. FLYVBJERG: Good afternoon.

MR. T. WILLIAMS: My name is Tom Williams. I'm representing a group known as former government officials for the period of 2003 to 2015 – which is the majority of the carriage of the Muskrat Falls Project. In particular, I represent elected officials as opposed to bureaucrats or project teams within the government. So these would be elected representatives, being premiers, as well as ministers of Natural Resources, which is the department that would have oversight for this project within government – just to put it in context.

Given that you're our first witness at the Inquiry, my questions are more of a general nature, because I think it's very important at this stage of the proceedings that the public is not misconstrued with respect to some of the findings in your report. And the reason I say that is that I understand from the scope of your terms of reference, your report is more of a generic application to megaprojects. Would that be correct?

Historically, when you are retained with respect to doing a review of a megaproject, in terms of – I'm not asking specific examples here. But if you are looking at a specific project, is your scope of review involved obtaining particulars of that particular project, being financial data or doing investigations of the project or interview of project team managers or members?

DR. FLYVBJERG: It might involve all of that, you know. Sometimes we get the data without having to be involved with the project at all, you know. It's very clear from annual reports, for instance, from an organization that have been audited and approved by auditors and so on, and we have the written document on that with all the necessary information. So that's one way of doing it.

Another way would be to go out – we did that a lot in the beginning when we set out with this work. We actually went out and canvassed organization – met with the lead engineers and the lead economists in the organizations in order to get the data and get access to the documents inside the organization and then use that as a basis of establishing the data.

So, all of the things that you mentioned are things that we do. We don't necessarily do all of them in the same way on each and every project. It depends on what needs doing in order to establish the validity and reliability of the data.

MR. T. WILLIAMS: So in order to be able to reach conclusions as to whether or not a particular factor exists or is an influence on how a project proceeds, you would need to review the actual data in respect to that project in order to reach that – form a conclusion, I would suspect?

DR. FLYVBJERG: Yeah, if we were interested in seeing how a project proceeds, but sometimes

we are just interested in how much did it cost, how much did they say it was going to cost in the business case. Those are the only two numbers that we go for, for some projects.

If we can get all that additional information, that's great, but we don't need it in order to do the kind of statistical analysis that we're doing.

MR. T. WILLIAMS: Okay.

So again, with respect to your engagement for purposes of your evidence today, this is of a general nature, not specific to the project that for which the Inquiry is subject to?

DR. FLYVBJERG: Correct.

MR. T. WILLIAMS: Okay.

Now, given the strength of some of the language in your report, and in particular I'm referencing page 4 of the report.

UNIDENTIFIED MALE SPEAKER: So this would be P-00004 again?

MR. T. WILLIAMS: Under the Executive Summary, just about three quarters of the way down – yes, this paragraph right here. It states: "This leaves optimism and political biases as the best explanations of why cost and schedule are underestimated. Optimism bias and political bias are both deception, but where the latter is deliberate, the former is not. Optimism bias is self-deception."

Can you expand on what you mean by that line?

DR. FLYVBJERG: The last one: "Optimism bias is self-deception" – is that that one: "Optimism bias is self-deception"?

MR. T. WILLIAMS: Yes, political bias being deliberate deception.

DR. FLYVBJERG: Okay, yes. So, this is the political organizational bias and pressure that we talked about earlier where you have people who are jockeying for a position for their projects. They want to make their project look good on paper. So in order to do that, they present it in, you know, attractive terms. And for a project to be attractive on paper, it needs to look cheap,

you know, to increase your chances of getting it funded. And it needs to look as if it can be done, you know, in a reasonable period of time, and it needs to show that it produces great benefits.

So, you adjust the cost down, the schedule down and you adjust the benefits up, would make your project look good on paper. If that's done deliberately, that is what I mean by political bias. That's strategic misrepresentation and it's deliberate.

Optimism does exactly the same, but it's not deliberate; it's done innocently, so to speak. Because of our cognitive biases, we actually believe – we truly believe that we can do it in the time that we set aside, even though it is optimistic. We truly believe we can do it on the budget, even though it is optimistic, and the same with the benefit.

So that's the difference between the two.

MR. T. WILLIAMS: Okay.

So in instances where you've been able to specifically find that there is either deliberate or innocent bias present, you would have specific examples of that by members of the project team or leadership member – someone of that nature, I trust.

DR. FLYVBJERG: Yes.

MR. T. WILLIAMS: And so, in keeping with that theme, I trust you can confirm that in preparing your report you have not spoken with, met with, or interviewed any political leaders, any political participants, any project team managers, any CEOs in relation to this specific project.

DR. FLYVBJERG: So the Muskrat Falls Project?

MR. T. WILLIAMS: Muskrat Falls.

DR. FLYVBJERG: I have not.

MR. T. WILLIAMS: And so you are not able to reach any conclusions with respect to the presence of any of these influences in regards to this project 'cause you weren't asked to do so. Is that correct?

DR. FLYVBJERG: That is correct.

MR. T. WILLIAMS: Okay.

With respect to your report, and on the same page – just – if we could just go down a little further. I just wanna get the bullets – all the bullets that are on the end of that page. Yes, thank you. That's fine.

The report references a number of factors such as viability and risk assessment, oversight, accountability and transparency. And you go on to speak of these being factors that we really need to evaluate in order to – I think the term you use is de-bias project plans and proposals.

At what stage do we use these tools? Is this an ongoing process, or where would you suggest these assessments need to be brought into a project development in order to have an influence to what you call, you know, de-bias a project?

DR. FLYVBJERG: Ideally, they would be brought in in the initial business case. Certainly, by the time you're doing the final business case on which – on the basis of which the decision, the sanction, is taken, you'd want this to have been done already. Unfortunately, that doesn't always happen.

So, sometimes we are being brought in when a project goes wrongly. So when it's hit by large cost overruns or large schedule delays, then people decide to reassess the project and then bring realism in because they realize that that the reason they don't – they are running out of money and running out of time is that they were optimistic at the outset and now they need to bring in the realism for the last parts – so they can deliver the rest of the project right and get it going, get it operational, right?

So the answer to your question is that it can actually be brought in at any stage but, ideally, you bring it in upfront and if you bring it in upfront and stick to it, then you don't need it later on.

MR. T. WILLIAMS: Okay.

And obviously there's so much in any megaproject that goes on prior to actual

sanctioning in the example that we have before us, it could be, you know, up to five years. So, what is the very earliest stage that you would recommend a project manager start to invoke these factors in order to ensure the elimination or the reduction of bias?

DR. FLYVBJERG: I would say from the very start because that would actually make it clear to you whether you should proceed with this project or not on a realistic basis.

MR. T. WILLIAMS: Okay.

Just one to two other questions. With respect to your comments on page 5 of the following page – the last bullet point on that page, if we could go to it. And you state: “Finally, maturity of leadership in capital investment projects is often perceived to be lacking. Investment in the development of project leaders, sponsors and stakeholders is necessary to increase the likelihood of project success.”

Now, I know you’re not speaking there in isolation of just political participants in this; you mean project managers, developers as well. But given the fact that so many megaprojects have government involvement and government administrative involvement, meaning it’s typically national governments or provincial governments or bodies such as that are participants in these big projects, how do you suggest that you invoke some form of maturity of leadership?

I mean while I appreciate it’s a very ideal concept, you know, something that we’d strive for, it seems nearly idealistic in the fact that, you know, these people are individuals elected by the owners of these projects, being the voters. How do you suggest that we invoke instituting maturity of leadership in project development?

DR. FLYVBJERG: By sensitizing your constituency and leaders like this, including elected politician, sensitizing them to the issues that we’re talking about here today at this Inquiry. And we are actually doing that in the UK, you know. I’ve had several ministers at Oxford, you know, talking about these things, sensitizing them to these issues, because they feel and their permanent secretaries feel that this

necessary in order to manage what is going on in their ministry in a responsible way.

MR. T. WILLIAMS: So are we talking about training, sensitivity training?

DR. FLYVBJERG: When I talk about sensitizing, I don’t mean sensitivity necessarily, but I do mean that people begin to understand what is at stake when you do a megaproject. And that’s very useful information for a minister or other elected officials to actually understand: What is it that is at stake when you invest several billion in something? What are the patterns that develop? What does it mean to the rest of the budget in the ministry?

You know, you can totally screw up the budgeting and the accounts for a whole ministry if one megaproject goes wrong – you don’t have money for all these other things if you need to use it on the megaproject, things like that.

MR. T. WILLIAMS: Would you agree a certain element of this is outside of the control, though, of parties to be able to institute this in any kind of formal way?

DR. FLYVBJERG: Out of control?

MR. T. WILLIAMS: Out of the control of project managers, that they are –

DR. FLYVBJERG: Oh yeah.

MR. T. WILLIAMS: – left with –

DR. FLYVBJERG: This is something that –

MR. T. WILLIAMS: – powers that be that they’re dealt, you know, they’re dealt – they play the cards that they’re dealt with.

DR. FLYVBJERG: I agree this is out of the control of program managers and project planners, but it’s not out of control of a Cabinet office or a Treasury to, you know, take the big overview and say, hey, this is an area that we need to get a handle on, because not having a handle on is not – it’s like having a bull in a china store, basically.

MR. T. WILLIAMS: Okay.

In looking at many of the graphs and the numbers, the probabilities and percentages that have been put up for the Commissioner, arising from your report, the problem that we're here facing today is nothing unique, I trust.

DR. FLYVBJERG: Correct.

MR. T. WILLIAMS: And that, in particular, hydroelectric projects – even as opposed to many other megaprojects – are probably more susceptible to project cost and schedule overruns than any other form of megaproject. Would you agree?

DR. FLYVBJERG: Apart from nuclear power plant projects, yes.

MR. T. WILLIAMS: Sorry, with the exception of nuclear power.

DR. FLYVBJERG: Yeah.

MR. T. WILLIAMS: So, this problem we're faced with is not unique to Newfoundland or to the Muskrat Falls Project. This is quite common.

DR. FLYVBJERG: Correct.

MR. T. WILLIAMS: And can nearly be expected of a project of this scale.

DR. FLYVBJERG: Correct.

MR. T. WILLIAMS: Okay.

DR. FLYVBJERG: But can still be prevented.

MR. T. WILLIAMS: And still be correct – and looking forward, going forward, I'm not suggesting that it justifies it, I only suggest it as realistic as opposed to optimistic.

How often would your company be retained by either a government entity, or a project manager, or development at the very outset of a project prior to the planning stages?

DR. FLYVBJERG: Often.

MR. T. WILLIAMS: Frequent.

DR. FLYVBJERG: Yeah.

MR. T. WILLIAMS: So, is that a recent trend?

DR. FLYVBJERG: It's a fairly recent trend, yeah, and it's becoming more and more common, but I still have to say that there are at least as many calls for projects that feel the pain, you know, and have gone wrong, and now want to correct it later in the project cycle.

MR. T. WILLIAMS: And with respect to – not to reference the Muskrat Falls Project specifically, but in the case where you have a megaproject which is, you know, substantially complete, how do we start to right the wrongs? How do we start to identify the issues to see if there's any corrective or mitigating measures that can be even taken at that stage in the development?

DR. FLYVBJERG: So, what is the precise stage again?

MR. T. WILLIAMS: Well, I said I wouldn't reference Muskrat Falls but the project in particular in this case is sometimes cited to be – it's close to 90 per cent complete.

DR. FLYVBJERG: Mm-hmm.

MR. T. WILLIAMS: Is there any steps that you would recommend, without getting at the specific references to this project, that could be undertaken at this stage to try to mitigate any further or ongoing risks that may exist?

DR. FLYVBJERG: I would have to know the – I would really have to know the detail of the project in order to address that question.

MR. T. WILLIAMS: Okay.

And that's fair comment.

Thank you. That's all the questions I have.

THE COMMISSIONER: Dr. Flyvbjerg, how are you doing? Should we take a break now? Would you like to take a break or –?

DR. FLYVBJERG: A break would be nice, yeah, but it doesn't have to be long.

THE COMMISSIONER: Okay.

Ten minutes.

DR. FLYVBJERG: Yeah.

THE COMMISSIONER: So, we'll break for 10 minutes, come back in 10 minutes' time.

DR. FLYVBJERG: Thank you.

CLERK: All rise.

Recess

THE COMMISSIONER: All right, counsel for Julia Mullaley and Charles Bown.

MR. FITZGERALD: Justice, I don't intend to be repetitive. I don't have any questions for this witness.

Thank you.

THE COMMISSIONER: Thank you.

All right, counsel for Robert Thompson.

MR. COFFEY: Commissioner, Bernard Coffey.

I have no questions.

THE COMMISSIONER: Okay.

Counsel for the Consumer Advocate.

MR. PEDDIGREW: Good afternoon, Professor. I'll be relatively brief, just a few questions for you.

Just – I've heard the term a few times used this afternoon: A mature project proponent or a mature project manager. What – when you say the word "mature," what do you mean? Is that based on a certain number of projects that have been managed or ...?

DR. FLYVBJERG: It's based on – yeah, that would be part of it. Experience generally, you know, with doing projects like this. And in order to have that experience you'd typically have done a few, yes.

MR. PEDDIGREW: And in terms of a hydro project, I mean without necessarily putting an

exact number on it, but how many projects would you have worked on before you become a mature hydro development project manager?

DR. FLYVBJERG: You know, you can't put a rigid number on it. This is not rocket science, but I'd say a few.

MR. PEDDIGREW: A few.

DR. FLYVBJERG: Yeah.

MR. PEDDIGREW: When looking at your reference class forecasting or some other form of risk mitigation, if a project was being managed or put forward for the first time by a project owner, would that factor in and if so, how?

DR. FLYVBJERG: Could you please repeat that?

MR. PEDDIGREW: If it was the first hydro project that a project owner was developing –

DR. FLYVBJERG: Yeah.

MR. PEDDIGREW: – I'm just wondering how that would factor in, if at all, into the –

DR. FLYVBJERG: Okay.

MR. PEDDIGREW: – reference class forecasting or other forms of risk mitigation.

DR. FLYVBJERG: That would factor in, in the sense that it would be more risky. I would consider it more risky if it's the first time you're doing this. And if that also means that it's the first time the project team is doing it, definitely more risky.

And you'd want to take that into account up front and just realize that, okay, this is the way we're doing it. And maybe it's the only way you can do it and maybe you can't get these other people. That's actually quite common; you can't get the experienced project leaders on project.

And then you'll just have to make that part of the risk assessment that you might be exposed to higher risks than average or than you would've been if you'd had the experienced people on your team.

MR. PEDDIGREW: Is that something that would impact the P-factor?

DR. FLYVBJERG: It would –

MR. PEDDIGREW: (Inaudible) it?

DR. FLYVBJERG: Yes, it would impact the P factor.

MR. PEDDIGREW: So more of a reason to pick a P80 as opposed to the P50.

DR. FLYVBJERG: More reason to choose a higher P-factor. And, also, it would mean that when you're trying to assess how high is the risk for the project that we're doing here, that you'd need to realize that you'd be above average in the reference class.

So, you know, if the projects in the reference class, on average, have had more experienced team than your own team, it would mean that your risk is higher than the projects in the reference class, and you make an adjustment for that when you are doing the reference class forecast.

MR. PEDDIGREW: In the studies that you've done putting together your research, or the results of your research, have you come across many examples where projects have been put forward by the project owner where it was the first time that they were managing a particular type of project, whether it's oil and gas, or roadwork, or ...?

DR. FLYVBJERG: Yes, that is actually quite common.

MR. PEDDIGREW: Okay.

And based on looking at the risk management or risk mitigation factors they put in place, were – was that something that they factored in?

DR. FLYVBJERG: No, mostly not.

MR. PEDDIGREW: Something – on a hydro project, something like the availability of sufficient water to power the actual project, is that something that would be factored in when looking at your reference class forecasting or other risk mitigation?

DR. FLYVBJERG: Do you mean in the report here?

MR. PEDDIGREW: Just generally, in a hydro project. Something like sufficiency of water, is that something that should be factored in if there's a concern about sufficiency of water.

DR. FLYVBJERG: If there's a concern about that, yeah, obviously it should be factored in in the analysis that you do up front.

MR. PEDDIGREW: What about the existence of prior reports that may have been commissioned by –?

DR. FLYVBJERG: Sorry, prior what?

MR. PEDDIGREW: A prior report –

DR. FLYVBJERG: Prior report.

MR. PEDDIGREW: – or study that may have been commissioned by one of the parties involved in the project, if it came back negative in terms of its views on the project, is that something that would factor into the risk mitigation?

DR. FLYVBJERG: Sorry, I have difficulty understanding – negative in terms of?

MR. PEDDIGREW: A report that came back with a negative view –

DR. FLYVBJERG: Okay.

MR. PEDDIGREW: – initial negative view of the project, and then if, subsequent to that, there was a – more risk assessment done, would the existence of the prior report being negative – is that something that you would factor in if you were assessing risk in a project like –

DR. FLYVBJERG: So was the report negative in the sense that it identified high risks – is that what you mean by negative?

MR. PEDDIGREW: Well, the viability of it overall, whether or not it was viable.

DR. FLYVBJERG: So the report would document that this is a non-viable project.

MR. PEDDIGREW: Yes.

DR. FLYVBJERG: And then you are asking whether that is something that should be factored in –? That's definitely something you take a look at, yeah. If you're doing risk assessment you're – is this a realistic assessment, you know, that is coming to the conclusion that it's a non-viable project and you might wanna test that on your own data and in your own report.

So my answer would be, yes, you would take that into account.

MR. PEDDIGREW: Okay.

Thanks, that's all my questions.

DR. FLYVBJERG: Okay.

THE COMMISSIONER: Thank you.

Former Nalcor Board Members?

MR. GRIFFIN: I have no questions for the witness, Commissioner.

THE COMMISSIONER: Okay.

Manitoba Hydro International?

MS. VAN IDERSTINE: I have a couple questions.

Good afternoon, Dr. Flyvbjerg. My name is Helga Van Iderstine; I am counsel for Manitoba Hydro International. I just wanted to ask you a couple questions about that optimism bias, and I – which I understand, you base on Dr. Kahneman's research. And he was a psychologist, I gather, who has an expertise in behavioural economics.

DR. FLYVBJERG: Well, he wouldn't consider himself a behavioural economist, even though he's considered the founding person of behavioural economics. He's – he actually said that he was surprised he got the Nobel in economics because he never did economics. So he would just consider himself a behavioural psychologist.

MS. VAN IDERSTINE: And it's fair to say that the concept of optimism bias applies to proponents of all types of projects, not just megaprojects or hydroelectric projects?

DR. FLYVBJERG: Yes.

MS. VAN IDERSTINE: And so something, I think, as simple as a wind farm, for example, it would apply to that in this context?

DR. FLYVBJERG: Yes.

MS. VAN IDERSTINE: And it would apply, as well, to how you might – I think you used the Olympics as an example – it applies to large projects with multiple components, as well.

DR. FLYVBJERG: Yes.

MS. VAN IDERSTINE: And I – you have defined a megaproject as being anything over a billion dollars, is that right?

DR. FLYVBJERG: Correct.

MS. VAN IDERSTINE: So a – anything that was in the \$6 to \$8 billion range would fall within a megaproject?

DR. FLYVBJERG: Yes.

MS. VAN IDERSTINE: And is one of the problems with projects that have multiple components, like the Olympics or any other multiple-component type project, that there are a lot of variables that you have to consider which might drive up the costs because of the unpredictability of all those variables?

DR. FLYVBJERG: Well, there's nothing – you know, there's nothing in unpredictability itself that would drive up costs. If you already knew that things were going to be unpredictable, you would take that into account. So the unpredictability of megaprojects is very predictable; the cost overruns on megaprojects is very predictable, as we can see on the – in the numbers that I presented earlier, right?

But you're right that they are unpredictable.

MS. VAN IDERSTINE: And in your – the data that you have in exhibit P-00004 on page 11 of

your report, you reference a number of hydroelectric projects in Canada. Do you – did that include, like, one-megawatt projects as well as 2,000-megawatt projects?

DR. FLYVBJERG: No. Those are only large-scale projects.

MS. VAN IDERSTINE: And can you tell us where you got that data from?

DR. FLYVBJERG: We got them from different sources, so I don't remember the specific sources. So it was other people on my team who were collecting the data, and I don't know the specific sources right off the top of my head.

MS. VAN IDERSTINE: So do you know whether those were private or publicly owned hydroelectric projects?

DR. FLYVBJERG: I have the names of the projects if that would help you.

MS. VAN IDERSTINE: Some of them might help.

DR. FLYVBJERG: W. A. C. Bennett, Sir Adam Beck Hydro, Robert-Bourassa, La Grande-2, Wells, Revelstoke Long Spruce are some of the names.

MS. VAN IDERSTINE: Does it include Limestone?

DR. FLYVBJERG: Limestone is not mentioned here.

MS. VAN IDERSTINE: And that's a megaproject in Manitoba that came in in the 1990s that was under budget, were you aware of that?

DR. FLYVBJERG: Okay.

So I mentioned these examples are the ones, so I can't rule out that Limestone might be in there – in one of the 19 projects. But it's also very likely that there are projects out there that we weren't able to get the data for, so they're not included. There's very likely to be hydro projects here in Canada that are not included in our analysis.

MS. VAN IDERSTINE: Yeah.

And if those ones weren't included it would change your data in terms of whether there was cost overruns –?

DR. FLYVBJERG: Provided that we could get reliable data. I mean, if reliable data exists for these projects, they should be included, because our principle is to include all projects for which valid and reliable data exist. But there are lots of projects out there where people would say, hey, this came in on budget, you know.

And when we sit down and we apply our criteria and we analyze it, it actually turns out that it's not the case – that the baseline uses was something different – much later baseline – which makes it much easier to argue that a project is on budget than the early baseline for the business case that we're using.

MS. VAN IDERSTINE: And if you're looking at that data from the perspective of somebody who's doing a review, using past – or other references – other projects the way you have, that would be an appropriate way to draw on experience, I take it, to reference your analysis?

DR. FLYVBJERG: Sorry, I didn't understand the question.

MS. VAN IDERSTINE: So if you were doing some analysis of the – of a project, looking at past experience with similar projects would be one way of drawing on data and determining the validity of your assessments.

DR. FLYVBJERG: Yes.

MS. VAN IDERSTINE: And I think you used the term benchmarking. Is that how you would describe that, looking – drawing on similar experiences or other projects?

DR. FLYVBJERG: Benchmarking is one thing you could do, yes.

MS. VAN IDERSTINE: If you look over on page 11 of Exhibit P-00004, table 5 – sorry, excuse me – page 6, table 1.

You used a median cost overrun for hydroelectric projects in this table. Do you know what the median cost overrun is for Canadian hydroelectric projects?

DR. FLYVBJERG: Not if it's not in here.

MS. VAN IDERSTINE: It's not in your report, so you don't need –

DR. FLYVBJERG: Okay.

MS. VAN IDERSTINE: – to look for it. I –

DR. FLYVBJERG: Then we don't have it. I mean – but it could easily be calculated. That would be not a problem at all.

MS. VAN IDERSTINE: Was there any reason why it – you chose not to use it anywhere in your report?

DR. FLYVBJERG: No.

MS. VAN IDERSTINE: One of my friends at the table – I'm afraid I don't know all their names. I've forgotten them – was asking you about your report that was filed as an exhibit, I think it was Exhibit P-00134: What You Should Know About Megaprojects and Why: An Overview.

So when I saw the name of that one, I actually looked it up on the Internet and I saw that there was a draft 9.2 on the Internet. I take it you do multiple drafts of these reports before you finalize them and send them in for publication?

DR. FLYVBJERG: Yeah, of course.

MS. VAN IDERSTINE: And other people would review them with you to ensure the facts and things like that are correct before you finalize them?

DR. FLYVBJERG: Yes. Plus, they are peer reviewed by the journal –

MS. VAN IDERSTINE: Yeah.

DR. FLYVBJERG: – that they are published in.

MS. VAN IDERSTINE: And similarly, did you have that kind of review of your report before you'd submitted the one for – is it filed as Exhibit P-0004 here?

DR. FLYVBJERG: Yes. It went through several versions and several people looked at it, yes.

MS. VAN IDERSTINE: Thank you.

Those are my questions.

THE COMMISSIONER: Thank you very much.

Mr. Simmons, I cut you short because I was concerned that we wouldn't have enough time for all counsel to ask questions. I can give you another 10 minutes if you wish.

MR. SIMMONS: Commissioner, I think with the other questioning that other counsel have carried out, I think the topics are reasonably well covered now.

So thank you very much for the opportunity –

THE COMMISSIONER: No problem.

MR. SIMMONS: – and we'll be fine.

THE COMMISSIONER: Mr. Learmonth, any redirect?

MR. LEARMONTH: No redirect.

THE COMMISSIONER: I just have a couple of questions, Professor.

I'm interested in trying – it sounds to me like you have a good deal of experience in megaprojects, and I'm interested in actually what – you know, you talked a little bit about the international efforts that have been taken in the UK, Hong Kong, Denmark.

I'm just wondering what other information you might be able to provide to me related to what governments are doing, particularly, for public-funded projects; what they're doing to ensure that they actually have a good handle on the cost before they sanction and then with regards to oversight of construction.

DR. FLYVBJERG: So I would say one thing is training. You need good people. You need qualified people, and there are not enough. And this is not anybody's fault.

This is just an area – megaproject planning and management is an area that has exploded, if you look at the expenditure. So it's just been very difficult to keep up with developing the talents that is necessary in order to spend all that money in an effective way. So I would say – we call it, you know, megaproject leadership academies. And we actually recommend that any government that are doing a lot of megaprojects and any private organization that are doing a lot of megaprojects should have a megaproject leadership academy where they train people and, again, sensitize people to the issues and show what the data is, what the methods are that you can use in order to curve the issues and the risks that are involved. So that is one thing.

And the other thing is to – in order to actually be able to manage public funds prudently. But with the amounts of money that are at stake here, you actually need realism, otherwise – so in the UK, the reason that the UK government started to work on this was that there were so many megaprojects that had such large cost overruns that the Treasury actually couldn't make the national budget in a reliable fashion, because all these project blowouts would blow holes in the national budget in a way that the Treasury, at the Ministry of Finance, would not be able to have a reliable budget for the whole nation. That's how, you know, impactful this issue is.

So that's the second thing, is to make sure that in all parts of the public sector that you actually have methods that will give you realism in your budgets. And that is possible. That's part of getting the realistic business case upfront that we talked about earlier. And those are two main things.

An additional thing that I think is important is that once you start delivery, we find that a pervasive problem is that when projects start going wrong this is not reported early enough. So we've developed something we call early warning signs for megaprojects.

And we've done this because we have seen several organizations that if they'd just known earlier what was going wrong and had been able to deal with it earlier, they would have been able to deal with it. But because – in many organizations there's a culture of nobody wants to bring the bad news to the leadership. So the

bad news stays down in the organization, and it's not escalated up to the levels of the CEO and the board where it needs to be, or the permanent secretary or the senior responsible officer, or whatever you call it here in Canada – those are the British names.

And if the decision makers who need to make the decisions do not have the information of the problems, they can't act on it. And this is what – we're often talking about delays of, you know, half a year, a full year, one and a half year, where you actually could've done something to get a project back on track where it's not happening, because nobody wants to bring the bad news forward.

So we need a change in culture where it's actually looked upon positively that somebody dares to say that this is not going right, these are the problems right now, and also have systems of where the early warning signs get detected and escalated to the right level when they happen.

So these are some of the things that are important to do.

THE COMMISSIONER: So just on the issue of trying to introduce realism into the project, is there like – are these countries using legislative means, regulatory means? What are they doing and how are they doing it?

DR. FLYVBJERG: Mainly regulatory means for the realism parts.

THE COMMISSIONER: And what are they doing?

DR. FLYVBJERG: So they write detailed government regulations about how you actually have to develop your business case and what methods you have to use, what data. In the UK they even specify the data that you have to use in doing it so that it becomes more difficult to avoid using unrealistic data, unrealistic methods and so on.

THE COMMISSIONER: And so would this data – like, for instance, the data that would be had in the UK – would that be data that could be applied to just the transport sector, or is it something that could be applied generally?

DR. FLYVBJERG: Generally.

THE COMMISSIONER: Generally.

DR. FLYVBJERG: Yeah.

THE COMMISSIONER: Are there any small jurisdictions – I’m thinking of smaller countries because we have to – I’m looking at Newfoundland and Labrador being a relatively small province in a large country, large geographic country. Are there any smaller countries that you’re aware of in Europe that are actually doing the same sort of work as, say, Denmark – well, Denmark’s not that big, but UK and other countries? I understand, for instance, that there is some work being done in Belgium; there’s been work done in other places as well.

DR. FLYVBJERG: The Netherlands. So I worked with the Dutch government on several instances of reference class forecasting for them, but they are actually much bigger than Denmark; they’re three times as big as Denmark. Denmark is 5.5 million and I would say that’s the smallest nation that is doing this. But you’ll also find municipalities, you know, that are smaller than Newfoundland and that would be doing these things.

So I don’t think that – of course it’s a question of resources. If you’re talking about doing something like a megaproject leadership academy, then you’d have enough – you want to have enough projects, enough volume to actually do it or you’ll find somebody else to do it with. But the methodology itself about being realistic up front and having early warning signs and so on, I don’t think, you know, it’s prohibitive for even a smaller administrative unit. I could see how a leadership academy might be.

THE COMMISSIONER: Right.

So is there any – just for my own assistance, would there be any country or countries that you would point to as being, doing this better than others, from your point of view, and that I could have a look at their regulatory regime and whatever?

DR. FLYVBJERG: So if you want to look at regulatory regime, the UK is the furthest. And

they have lots of documents produced that, you know, where they spell this out in great detail. And they even have the advantage that they’ve been at it for so long that they’ve had time to accumulate the experience and use that to revise the documents and improvement – improve them. And so that has happened over the past couple of years.

So there’s quite new stuff to build on. Hong Kong is probably the most consistent; they take it most seriously and really, you know, implement it with fervor. But they are in the process of doing it right now so they don’t have the same experience, they haven’t stepped back from it and looked at it and asked themselves so what are the lessons like the UK has.

So I’d probably say that the UK would be the first place that I would look, maybe Hong Kong if you have the capacity to do it.

THE COMMISSIONER: Okay.

And just one other question related to oversight. So there’s two bits of oversight that I want to talk about; one is you would have a proponent or somebody who is actually engaged in a megaproject. And I’d like you to speak to me a little bit about what you would expect with regards to oversight once construction has commenced.

And the second area would be where there is, such as in this situation, a government that is basically sponsoring, so to speak, the project that is being carried out by a Crown corporation, can you speak to the type of oversight that you would expect to see in those situations?

DR. FLYVBJERG: Yeah. So I don’t know what the situation is with Crown organizations here in Canada, but in some countries, including my own in Denmark, they actually have too much power in relation to the government. So they are difficult to oversee because they see themselves as, hey, we’re not part of the government, we have separate power, and there’s only these few things that we actually need to be monitored on, and they will defend that fiercely.

That’s a problem because the money is actually coming from the government. And given that the

entity that pays should certainly have oversight of what's going on, it's a problem when the, what we call state-owned enterprises, which is sort of the more generic term for a Crown company, when they gain too much power.

So that's something to look into to make sure that the government actually has the rights and the ability to oversee the Crown company.

THE COMMISSIONER: And with regards to the company itself that's constructing the project, what type of oversight would you expect to see?

DR. FLYVBJERG: So I would want to know the realism of the business case up front so to have due diligence of the business case where you actually – you assess is it likely that it'll be possible to do it at this cost? Is it likely that it can be done on this schedule? Is it likely that it will generate these benefits that are, you know, stipulated in the business case? So that will be a sound due diligence of the business case upfront.

And then I would want, at certain intervals throughout a project delivery, to get a realistic picture of what's going on here. Are we delivering to schedule? Are we delivering to budgets? And if not, what's going on and what's the risk that contingencies have to be released and so on? Or, ultimately, in the end the taxpayers – additional taxpayer's money have to go in. So a reliable system that makes sure that you, the government – the government as the ultimate project owner actually gets that kind of information and can sanction the Crown company and the project if things start going wrong.

THE COMMISSIONER: All right.

So how would that – so with regards to having it at certain intervals, what would happen if during the period between the two intervals, for instance, that something did come up that was obvious that costs were going to increase or the schedule was going to be delayed. Would it still be, in your view, incumbent upon the company to make that known to the person that they're basically building for?

DR. FLYVBJERG: Yes.

THE COMMISSIONER: Okay.

So that would be the early warning, sort of, scenario –

DR. FLYVBJERG: Yeah.

THE COMMISSIONER: – that you talked about.

DR. FLYVBJERG: Yeah.

THE COMMISSIONER: All right –

DR. FLYVBJERG: There might be minor stuff where that would be the case. But anything major that has, you know, the risk of adding, you know, a certain amount of money to the budget or a certain amount of time to the schedule and this can be defined, you know, what the thresholds are. So things that reach that threshold would be reported to the owner.

THE COMMISSIONER: All right.

Dr. Flyvbjerg, I have to say to you that after being appointed to chair this Commission, the first thing I actually did was pick up the book that was given to me and read it. It happened to be a book written by yourself and I have to say that it is a pleasure having you. I really appreciate the fact that you've taken the time to come here. I know there wasn't business class on the plane and I know you had to fly through Deer Lake. So you've experienced Newfoundland, really, the way it is. But I do appreciate you coming and I appreciate your testimony.

Thank you very much.

DR. FLYVBJERG: Thank you very much.

THE COMMISSIONER: You can step down, Sir.

So it's now a little earlier than I anticipated we would be finishing today. We're going to be starting tomorrow morning at 9:30. We will have, as I understand it, an opening statement by counsel with regards to the plans for the inquiry, which I would normally had today but I wanted to make sure that Dr. Flyvbjerg could get back to the UK tonight.

So we'll start with that tomorrow morning. We'll be proceeding then to four Indigenous groups talking about the use of the Churchill River, as I understand it. And there is a plan as well to talk about the history of hydro development along the Churchill River, and I'm not sure if we're going to get to all of that but hopefully we'll make a stab at it.

I appreciate your attendance today and we'll be back tomorrow morning at 9:30, and we will be breaking tomorrow at our usual time for an hour and a half, likely from 12:30 until 2.

All right. Good.

We'll break now.

CLERK: All rise.

This Commission of Inquiry is now concluded for the day.