[SQUEAKING]

[RUSTLING]

[CLICKING]

RICHARD DE NEUFVILLE: Now, when we had the move, the possibility to say, OK, we can relocate some of these things to a distant place and avoid some of the dispatch and transport costs, the solution there was, OK, maybe we want to move it to the most distant place, and we're going to do it-- the gas, we're going to transfer it by pipeline and not by truck, by tanker truck of the finished product so that that could save us some money.

And indeed, overall, having this solution for the numbers we had increased the expected value-- in this case, by about another 10%. But here's the kind of thing that happened is that, in this case, to be able to enable this flexibility, you had to invest in a pipeline. And that would cost some money. So under many cases, if you invested in it but didn't use it, you'd have this extra cost so that this pipeline solution was a disadvantage for all these. They would reduce the expected value, say, from about 11 here for both of the alternatives to something around, let's call it, 8 or 9. So it was significant over a range here.

But on the other hand, it was really great demand. It was a very profitable one. So you had a tradeoff to happen. So that very often, as in this case, if you would simply comparing the red line and the green line, it's not so obvious which is the better one or how you ought to organize it. So it does frequently happen, and you should expect it that it's not always, well, one is uniformly better. This kind of effect where investing in the flexibility has a cost. And just like I buy life insurance not to be morbid about it. I buy life insurance, and every year goes by, I've lost money on my bet, but I'm very-- in this case, I'm very happy with not cashing in on my life insurance.

So this has some comparisons, and it shows that the flexible with no move can increase not just the expected value but also other kinds of measures which I suggest that we should be taking into account regularly, which is, for example, the value at risk. So both the flexible with and without the move increased the-- improved the value at risk by 2 or 3 times here in comparison with what was happening with the fixed design. So the fixed design, you had a 10% value risk of 1.8. And here, you increased it to 5 or 4, basically.

And the same thing with the upside. You had considerable possible improvement. So it's not just a unidimensional thing. It changes not just the averages but the distribution of averages, on the one hand reducing the risk and increasing the opportunity. Those are the kinds of things that you would expect.

Now let's think about learning rates. And so being a parametric study, not knowing what the learning rate might be on this kind of construction, we assumed it was either nothing or it had different rates. And what you can see is, again, this is part of the tradeoff between economy of the scale and learning. If you're learning as you build modules, the later ones will be cheaper than the earlier ones. And so that it will decrease the overall cost of expansion, and this counterbalances the effect of economies of scale and increases the effect of discount rates, meaning the further you build it out in the future, the less expensive it's going to be.

And as you can see here-- I was trying to illustrate here that, for the no move analysis simply looking at changing the learning rate on the construction of the modules, it pushed out the maximum value you can have, the far end of the curve, meaning that if demand really grew and you build a lot but you build it in the future and it basically came to you at a very cheap price, you had tremendous advantages in terms of the expected value going from about 20 to about 50 in this particular case with these numbers.

And I wouldn't put much attention to these numbers because they're not backed by a specific case. But it in shows-- and the intent of this is to show that there is that distribution of change, and the learning rate can be really very powerful. So even if it goes from zero, none, to some, 5%, which is fairly modest, it has a change from 20 to 28. So it has a lot of leverage in there if there is a learning rate.

And this-- if you're making cars, you're going from having produced 100,000 to 110,000. It's not very much. But if you're producing big units such as in the Victoria desalting and you go from building one, your first time, you didn't know how to do it, to building a second and a third, the effect can be really quite significant when you're dealing in low numbers of units when the modules you're talking about are in the units, single units-- 1, 2, 3, 4, 5-- or even in the teens. So this can have a huge effect, which is the point of this graph.

So the general lesson 3 is the repetition of modules promotes learning, which is most impactful for initial replications. So learning can increase value significantly. Let me repeat the example that I think I cited earlier in the class but I want to emphasize in this context, is when BP was building platforms in the ROC near Azerbaijan their first they had for a variety of circumstances having to do with contract disputes with designers and what have you, they ended up building three identical units of platforms, which was very different from their traditional approach was to optimize, to have bespoke, tailor-made platforms for different sites where they had different expectations of the fuel coming through or the product coming through at different times, different depths of water, and so forth.

And in that case is the savings and labor costs were reported to be-- I reported-- I don't have the actual data for me, but it was reported to be about 40%. People knew what was going to happen next. They can schedule things better. They changed little bits of the way-- the order in which they did assembly. Anyway, it was like you and me, if we ever did this-- which I have, and many of you have-- put out a tent to go camping.

The first time you do it, you make mistakes and don't know what you're doing. And by the time you've done it several times, you're a lot more efficient. And maybe you can think a lot of other examples of when you go from the first time to the second or third times, you get to know the ropes, and it happens. So that's the general lesson is that this can have quite significant impacts-- can have, may have. It is not, of course, necessary.