[SQUEAKING]

[RUSTLING]

[CLICKING]

RICHARD DE NEUFVILLE: Now I'm going to talk about the second phase of the analysis. The first case was to look at the engineering base case. I'm now going to say, let's think about how the system will perform when we recognize the uncertainty.

And of course, in a particular performance-- in this case of the garage-- there are a lot of things that are uncertain. We don't know how many people will actually want to park there. We don't know how popular the garage is going to be. We don't if there's going to be competition.

So we really don't know what the performance is going to be. We are now going to explore, in particular, variability in the demand. You could also look at variabilities in the other factors, as we did for the platform case I mentioned in a previous presentation.

But in this one, we'll only look at the variability in the demand. So we assume for this analysis, as an illustration, that the future could be 50% off either way from what was projected, and that it could also be volatile-- that it could go up sometimes, and down the next time, and so forth. And that will affect the actual value that you calculated over time, whether or not it started off slow and then increased, or started up high and then decreased, because of the competition or the factors that may have occurred. So we look at all those kinds of possibilities.

Now, the effect of the uncertainty-- let's think about it in advance before we see the calculation. It changes results. Why is that?

Because there are nonlinearities in the model. That is, although the inputs were equally likely to be above and below, the results of the analysis are not equally likely to be above and below the projected amount. That is harking back to one of the earlier presentations.

Because of Jensen's law, the flaw of averages, what happens is it's a very nonlinear system. In particular, the garage, if it's built with six stories, can only service the amount of demand appropriate for six stories. If the demand was higher than that, it's limited. So it chops off the upside potential.

On the other hand, if the demand is lower than would be satisfied by six stories, you lose money. So the nonlinearity in here has the effect of lowering the results and because of these capacity constraints. This is a typical reaction effect of systems with limited capacity, whatever they might be-- a warehouse, a water desalination plant, electric power generation, whatever.

Things tend to have a fixed capacity or a maximum capacity. And that leads to nonlinearities in the results, chopping off the upside, allowing you to have lower-- or allowing you, giving you, lower performance overall. So this changes the design.

Why is that? It is because if you have that risk, and you lower the value, that it hurts you more when you've built larger. So systematically, it tends to push you the design-- the good design, the appropriate design-- for the actual conditions, with the uncertainty. It pushes to a smaller amount.

So to see how this happens, let's look at this graph here, which shows the results from the deterministic case, which go up quite high, and give you a design of about six stories here, six stories specifically. And what happens with the same case with the variability in design? Systematically, you get a lower value overall for all the floors.

Doesn't matter so much if you're at the extremes. But in the case of the count, it's significantly lower. And in this particular case, the sweet spot is not six stories, but five stories.

So what you also should note is that while we had a six story, and in this case, it had a high return, which is about $6 million here as its value, this is a fairy tale. Because the reality is we won't have a deterministic case. We'll have a variable case-- that there will be ups and downs in the demand.

And that leads to the actual performance of the system being constrained and systematically tends to be lower in value because of that nonlinear constraint that everything is lower. So that although we thought, in a deterministic engineering case, that it was a value of $6 million or so, the actual value, it would be about $3 million or something-- almost half in this particular case. Because of course, the costs are basically already fixed. So it's the amount of revenues that occur that lead to the value.

So the basic result is, in this case, the value calculated for the deterministic case was $6.2 million. The actual value, with the uncertainty as we've modeled it, was about $3.5 million, a significant difference. So the deterministic value in any case is false because the world is not deterministic.

The world is full of variability. And in this case, it's lower because of the capacity constraint on upside gains. And the deterministic analysis is wrong in two counts-- the value of the system as calculated is wrong, and the optimal design is not the same as it was before. So wrong, wrong twice. We've got to do better than that.