[SQUEAKING]

[RUSTLING]

[CLICKING]

RICHARD DE NEUFVILLE: I'm now going to give you the logic of the analysis for the garage case as that prototype example. The first step is going to be to consider what I'll call the engineering base case.

That is the way the engineering profession typically addresses such a question and show how it leads to a particular solution. And we'll be showing then how an analysis, understanding the uncertainties and everything, will give you a different solution.

So the second step, having set up the base case, is to look at how that system would perform under uncertainty. And that tells us that there is, in fact, some considerable downside, and we would want to do something about that.

And the third one then is to say, let's look at how we might have a flexible design, how we could then profit from it by not building so aggressively at the beginning because one has the option, the possibility of expanding later on as needed, which has the advantage of deferring the cost and maybe saving them completely if they're not needed. So we're going to have three steps of the total analysis. We'll start with the engineering base case.

So the deterministic design is for a major garage serving a mega-mall. In this case, the Bluewater case in England, for example. The actual demand over time is, of course, very uncertain. Why is that? Because we don't know the population growth. We don't know the demographics of the area over the next 20 years. We don't know whether the mall will succeed. Maybe they have the wrong stores in it. Maybe people don't like it. Maybe it'll be wonderful. We don't know. We just cannot know that for sure.

There may be competition also from other parking facilities. If somebody else opens a garage and gives you some kind of access to the shopping mall, maybe you'd prefer that.

So despite those realities that the future is very uncertain, must be uncertain, the engineering process does it to a fixed forecast. In this particular case, some traffic engineers, some urban consultants went through and predicted a forecast for the situation against which the engineering, the structural engineers that were doing it said, OK, what is the best way to meet that particular forecast given that forecast? Even though that forecast is a fairytale because the world will actually be different than what that forecast will be.

So they will optimize it. They'll find the highest value design. That's what optimization means. And in this case, you can do it fairly straightforwardly because the design variable, given that you have a fixed area, is how many floors do you have? One, two, three, four, six, seven, eight. So you can look at those cases and figure out which is the best one, which is what the process leads to.

And typically in this kind of situation, in the design situation you have some kind of sweet spot. That is if you build it too small, you don't have enough revenues to justify the cost of the leases and everything. If it's too large, you may have a white elephant. Somewhere in the middle typically there is a sweet spot.

Think for a moment what kind of graph that would have. What would happen in that case? What would the graph look like? Here is the response that you have. On the one side, if it's too small, this is one or two floors, you have that you're in losses. If it's too large, you can have losses because you have a white elephant.

Somewhere in here you have a sweet spot. And in this particular design with the particular values that we use, which were representative but they weren't exactly the ones for the actual facility, which we didn't have access to, but they were representative, there is a sweet spot. The optimal design, the one that maximizes the expected present value is six stories.

How did we calculate that? We used a spreadsheet where on the one hand we had all the various costs and revenues down here. We had what might happen in different years as the demand grew and as the performance went out.

And that leads to a simple calculation of the net present value as shown here. The optimum design is six stories. That is the result of the typical engineering process applied in this case.