[SQUEAKING]

[RUSTLING]

[CLICKING]

RICHARD DE NEUFVILLE: At this point, I'm going to talk about the third element of the garage case. We already started with the idea of what the deterministic engineering design was, then we saw how that analysis led to a wrong estimate of the value and, in fact, the wrong design once we accounted for the reality of uncertainty.

Now let's think how we can be proactive about this design, and we're going to do that by introducing flexibility. What does that mean? The flexibility is the ability to adjust the project to the actual needs, according to how the future develops. In particular, it means that if the future is very positive in terms of demand and you'd like to have greater capacity, that you have the capability of adding that if needed.

It also presumes that we are managing this project. We just don't create it and say, there. It's off on its own. It's on autopilot. No. We have a system where we manage it appropriately. So it's very important to understand that if we want to deliver the value of a design, it's not only what we do at the beginning, but how we manage the project as it encounters different situations and has to deal with different possibilities and opportunities.

How do we do this for the garage? For the garage case, what we do is we enable the addition of more capacity. That is, it has to have the strength to carry more loads, it has-- if you want fat columns with more strength on them, it has to have bigger foundations to carry the loads on the soil, and it has to have a building system that you can easily add to, in this case a precast situation.

You build it offsite, can bring it in, and can expand it with a minimal closure of the garage during the expansion period. So then you have the ability to add floors and what have you. Now, let's think about how we're going and analyze this with the simulation process. Here is a spreadsheet of it. And this is the one for four floors.

Now, what we have here-- I won't explain in the detail how it works, but I'll give you the idea of it, is that we have a forecast here, and this is a simulated forecast. That is, sometimes the top number of the forecast will be up, sometimes it'll be down. It'll be up and down over time. And that's what we observe. Then we think about how we would exercise, the flexibility that's available in terms of intelligent management.

So if the demand is not increasing, we do not add to capability. If the-- extra floors, in particular. If the demand however does increase, then it looks like it'd be valuable to have more floors on it, we add them. We've embedded in here through what's called if statements that looks at what's been happening and what would be the intelligent thing to do.

And for each simulation that we run, we factor that in and calculate the value. So we do this for thousands of times, a couple thousand in this particular analysis. And we look at-- sometimes you expand because it's desirable, sometimes you do not expand. We look at the combination and figure out the overall expected value.

So where does that lead us? It leads us to-- as we look at all the possibilities, one story, two story, and so forth with and without the flexibility, that the optimal design in this particular case with these numbers is not six stories, which was a deterministic design, not the five stories, which is the risk averse, avoiding the downside approach where you recognize the uncertainty, but it's four stories.

But four stories with the ability to expand when needed. So observe what's happening. You've built it smaller so it didn't cost as much as having five or six stories even though you had strong foundations. So it's less exposure to the downside, but you've built it so that you get five, six, seven, or eight stories if the demand occurred.

So here is the summary of the design results. So that on the one hand, we have the different possibilities and their performance over time, and we have the value at the end. So what we observe here is that the four story building is the most productive one. And we might have thought that the deterministic design with a value of 6 million was better, but that result is a sham because given the uncertainty, we will never get that result as the expected value.

Its expected value will be lower. And, in fact, in the case unc-- the reality case with the uncertainty is we'll get only about 3 million with it as the value as compared to what we get. So let's think about what's happening here. We build it smaller, less cost at the beginning, less possibility of loss.

On the other hand, we can build it up as much as seems appropriate in the particular conditions without a-- we have favorable demand and we can make more value. So let's look about what it is, how we think about this overall for this particular design case. So we need to have a multidimensional evaluation. Why multidimensional?

Because since we have a distribution, one number, one value for it is not describing what's happening. You care not only about the average, you care about, how bad can it get, how good can it get, what's the possibilities? In this particular case, that-- we see that the several factors that we're looking at in terms of the initial investment that we-- how much money do we have to put down to start the process? It is lower for the flexible design because we build it smaller.

So what's the expected value of it? It's very much larger than otherwise because we can take advantage of the good things and avoid the bad things. And in that same way, the maximum value we can get is larger, the minimum value that we might be forced to accept is smaller so that it's good in all cases.

So everything is better. How did that happen? We have not had a technological breakthrough in this case. It is not a more sophisticated or advanced design. It is because we have changed the design approach fro-- we've changed the framing of the problem that instead of going to, say, we're designing it for a fixed view of the future, and instead of focusing on this mythical and this fairy tale future that, in fact, will not be the exact case, we changed from that to managing the realistic uncertainties of life by having the flexible design and, therefore, can adjust to the conditions and, in that way, have an overall better solution.

Now, in this case, the flexible design was better on four counts that, as I mentioned, that may not always happen. Sometimes the situation is not so uniquely favorable, but it's the kind of thing can happen because it's built in to the way of approaching it as less downside, more upside, lower cost than beginning. Overall, it's a win-win at less cost.