[SQUEAKING]

[RUSTLING]

[CLICKING]

RICHARD DE NEUFVILLE: Hi, this is Richard again. And change of pace now from the sequence, I'm going to be talking about something called the flaw of averages. What is this? It's a fundamental problem in the design and evaluating of projects. And I'm going to take some time to explain it to you, and then in a following session, to talk about what its implications are.

So the flaw consists of-- or is the pattern of designing, evaluating projects based on the average or most likely future forecast. That is, thinking that, OK, here's what the forecast is going to be, or here is our best guess at the forecast. We know it's wrong, you've told us so, but we're still going to analyze it based upon one forecast. Then what often happens is that people will take some variation around it, plus or minus 10%, say. But the fundamental choice is that they're looking at it from an average or a projection.

Now what happens is that there is a fundamental misunderstanding of probability and systems behavior when you do that. So let me explain the name. It's a pun by Sam Savage who wrote the book, in fact, called *Flaw of Averages.* It integrates two concepts.

First concept is that there is a mistake, a flaw-- F-L-A-W-- flaw. And it combines that with the concept of the law of averages. That means that basically things work out on the averages so that the pluses balance the minuses and everything works out. So that if you design around the average, you'll be OK. That is not correct.

The error consists, in general, of assuming that the analysis based upon average or most likely should give correct answers. This is wrong. It's fundamentally wrong. And it's not a new discovery, it's a very old mathematical fact. It's called Jensen's law. I don't know why. I suppose that somehow he articulated it.

But all it says is that the expected value of something that's variable, the expected value of a function that is, say, the profit from a project, or its net present value, or some measure of goodness is not equal to that function evaluated using an expected value. In detail that says, if it's a convex function, but in general, it applies in all cases, so-- all practical cases.

So what it says is if you really want to know the average value, the expected value of something, you cannot do it around the looking at it and evaluating it at its most likely, or average, or most probable condition. And for the notation, the E of x simply means that the arithmetical average or expectation of that. And in words, we're talking about that the average of all possible outcomes-- that is, what's on the left-hand side here-- is not equal to the outcome calculated by using the average value.

Very simple concept. That is, put it another way, that if you really want to get the right value, you can't evaluate it around some most likely, or most probable, or average, or median forecast. You have to look at the whole distribution or some approximation of the whole distribution.

So in words, the flaw of averages is the average of all possible outcome associated with uncertain parameters. It generally does not equal the value obtained from using the average value of the parameters. That's the flow of averages in words.