

[SQUEAKING]

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**RICHARD DE NEUFVILLE:** So the question I wanted next to come to, does the valuation function, and I should have an underscore for the  $X$  to indicate that it's a vector, does it mean apply to groups? And the basic issue is, do all members of the group have the same sets of preferences? Well, that's not excluded. But in general, any groups are composed of stakeholders with different interests, like investors, managers.

Investors want the most return from it. The managers want more power and glory for themselves. The users want a good product. The workers want better working conditions and less work, whatever, less effort perhaps. And their collective interest almost certainly degree. So we can't expect them to agree. That is the point.

So let's now look at this simple example I have. So what I have there is that we have three perspective voters, Tom, Diana, and Harriet. And Tom is very much on the left. He's a Sanders fan, if you want to think of it that way. The further to the right you are, the less he likes you.

Diana, on the other hand, is the center-of-the-road person, doesn't like the extremes. She might be more conservative than towards the left. And Harriet is completely conservative. I won't characterize that particularly. But she doesn't like wishy-washy people in the middle, so she's either a right or left but not anybody in the middle. I'm not going to draw any comparisons with anybody currently in the election.

But now, I'm going to ask you, who wins the election? And I'm going to think of it in terms of these voters and the candidates that are done. And let me suppose the candidates are either left, center, or right. So I'm going to ask you, if it's the left candidate against the center, who wins? The center against the right, who wins? And finally, if it's the left against the right.

So the point is, I'm going to close it myself, because you see that left beats center, center beats right. So it was transitive, left would be center would be right. But in fact, if you structure, you fold out, it is not transitive, which is the whole point of it, a simple example of something that is not transitive. And the answer is that you have an intransitive situation.

That is, because of the structure, the detailed structure of people's preferences, that they're not ranking them in the same order, you can construct an intransitive solution very trivially. And it's simply to show that, because the people have different rankings of the particular things, whether it's food they eat or people they vote for or where they like to spend their holidays or whatever, it's very easy to set up an intransitive situation.

The bottom line is, because of this feature that you simply do not have the basis for a value function for groups, you can go through the math and say we're going to weight people this way or that way and we'll come to some solution and some people have are more important or more persuasive than others. But to think about being able to have a unique valuation function that you could optimize is a pipe dream.

So it is in some ways that you can agree to have a voting system, which people will agree upon. But it will not satisfy everybody and it'll leave some people unhappy, as we regularly see in elections. So the concept of "best" is not meaningful for the design of complex system. That's where this whole thing has been going.

But we can agree to some process, we can identify preferred one. But from a mathematical, optimization point of view, the idea that we can run a metric and have the optimal solution is only meaningful when we can have a single objective function or a combination where everything can be put on the same value, such as money. Otherwise, we are necessarily talking about a preferred solution. And that's the basis for the next issues here.