

As you work through and start describing a system of interest, you will likely come across what we call feedback loops. What's interesting about the idea of a feedback loop is that actually, this idea is not new. This goes back to the quote earlier from Donella Meadows, that a lot of this thinking is not new, yet sometimes new to different people. This idea of a vicious cycle, which many people have heard of, is known all over the world.

The idea of a feedback loop is really important in the dynamics of any kind of complex system and, in particular, when we're thinking fostering any kind of social change or social innovation. It's really important to understand whether there is a feedback loop that exists within a system because these can have profound effects on the dynamics of a system: either holding a system in place or driving a system off in a particular direction. And, if you're interested in changing that system, you will likely have an interest in changing a feedback loop of one sort or another, either decoupling a feedback loop to allow a system to move in a different direction or perhaps reinforcing a

feedback loop which might push a system in another direction. That speaks to different kinds of feedback loops, which I'll get to in just a minute.

This is a bit of silly—and I apologize—a bit of a silly example that really works on first-year students, especially after orientation week or frosh week; but it's one that many people can relate to. If you drink lots of beer, it will likely result in you getting drunk. So, the more beer you drink, the more drunk you will get, which results in a loss of inhibition, which results in more beer intake.

That is a positive—not in a normative sense—or a *reinforcing* feedback loop. You can also have what we call negative or balancing feedback loops and they can also come into play. So, drinking lots of beer leads to getting drunk, but can also lead to feelings of nausea or sickness, which prevents you from drinking more beer. That's like a thermostat. It stops you. It's a negative or a *balancing* feedback loop that stops you from drinking more beer.

You can also have drinking more beer leading to getting drunk leading to an annoyed partner—which is something I can relate to—which also prevents you from getting drunk. Then you can have drinking beer leading to getting drunk and running out of money—which is also something I can relate to—which prevents you from drinking more beer. These are very silly examples of *reinforcing* or positive feedback loops as well as negative or *balancing* feedback loops.

Generally, physicists and other people that use these kinds of diagrams will use positive and negative. I find that these are sometimes confusing because people associate them with the normative in the sense that this is a positive change versus a negative change, rather than positive in the sense of reinforcing or negative in the sense of balancing. So I like to use, and the resilience folks like to use, reinforcing and balancing feedback loops; so I'll try and use those terms from now on.

As I mentioned earlier, what you want to do when you start to create these kinds of

causal flow diagrams or causal loop diagrams or feedback diagrams is to try and make your understanding of the system more sophisticated. You will often have to add variables and think about the nature of the relationships between variables.

Again, we can start to make this diagram a little bit more sophisticated and think about adding these terms preventing and loss of inhibition and buying more beer leading to an empty wallet, and then we can take it a little bit further and start adding polarities to these kinds of relationships, as opposed to leaving them implicit, i.e., level of alcohol in the blood increasing reduced inhibition, which increases the pints of beer, which again increases the level of alcohol in the blood; or increasing pints of beer leading to an increased level of alcohol in the blood, leading to an increased degree of nausea, leading to a decrease in the number of pints of beer.

Again, what you're doing here is adding some variables, making your understanding more sophisticated, and adding these notions of polarities.

Again, just a couple of tips in terms of thinking about causal loop diagrams and ways to identify or draw these particular diagrams. You can think about adding polarities. You can think about whether they are reinforcing a causal loop or feedback diagrams or balancing and you label them as such to help you understand what's going on in a particular diagram.

You can have different feedback loops, as we've got here, impacting the same variables in different ways; or you can use just the generic positive or negative. Again, I'd probably recommend that people use the ideas of *reinforcing* and *balancing* to avoid this link with the normative.