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## What is System Dynamics, and what is System Dynamics Mapping?

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**System Dynamics** is an approach that makes sense of complex interactions between people, organizations, natural resources – any thing or things whose actions are influenced by others, and which influence others in their turn. Originally developed as a way of understanding natural systems like cell biology or forest ecologies, System Dynamics found a place in management and leadership science 20 years ago, and has been put into use in a variety of private and public organizations.

In complex systems, actions often have “perverse consequences” – unanticipated and counter-intuitive results that frequently unfold after a delay. Studies have shown that leaders routinely fail to take the possibility of perverse consequences into account when they make decisions.<sup>1</sup> As a result, many of those decisions produce results that are unlike, even opposite from, what was wanted. System Dynamics allows leaders to anticipate perverse consequences and craft plans that take them into account.

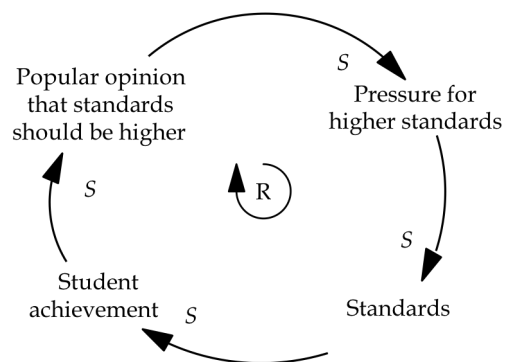
**System Dynamics Mapping** is one of the tools of System Dynamics, and is a way of capturing complex interactions in a picture.

For an example of a simple System Dynamics Map, consider the following story about standards from an educational consultant:

### *The Story*

*Popular opinion brings pressure to bear on our schools to raise standards. In response we raise standards, and students respond with higher achievement. Opinion makers like this, and so they continue to call for even higher performance standards.*

### The System Dynamics Map



*(The Ss in the picture indicate that each variable moves in the Same way as the one preceding it: thus, as standards increase, student achievement changes in the Same direction: it increases as well. The R in the center of the loop indicates that this is a Reinforcing system, one that leads to growth or decline.)*

The picture shows the reinforcing nature of this dynamic. Student achievement, pressure for higher standards and popular support will all continue to rise unless something interrupts the cycle – and something always does.

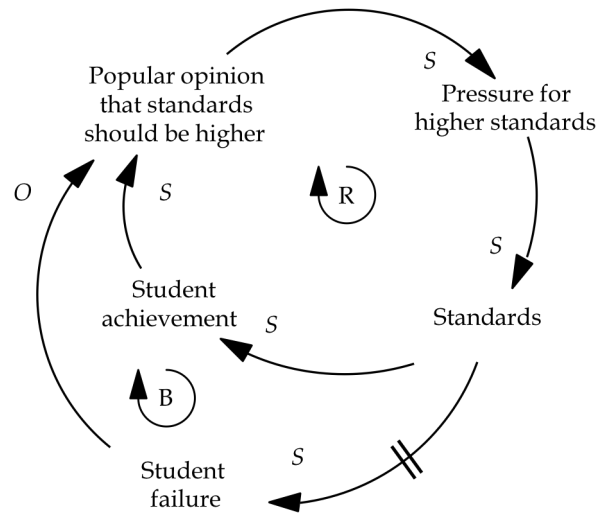
In the story that the consultant told, what interrupts the cycle is a natural consequence of the higher standards – that is, some students fail to meet the new standards. Once the number of failures reaches a critical point, they create a counter pressure on popular opinion, so that support for the higher standards begins to fall.

We can add elements to our map to show this addition to the story:

*The Story (2)*

*As standards increase, eventually the number of students failing also increases. As more students fail, popular opinion supporting higher standards also begins to diminish.*

The System Dynamics Map



*(The two short lines bisecting the arrow connecting “Standards” and “Student failures” indicate that there is a delay before the change in standards causes a change in student failures. The O indicates that “Popular opinion” changes in the Opposite way to the number of student failures – as the failures rise, opinion falls. The B indicates that these links create a Balancing system that “brakes” the growth of the original Reinforcing system.)*

This pattern is a very common one in System Dynamics, and is called “Limits to Growth.” This structure, or “archetype” as it is called in System Dynamics, can be seen in trends as varied as the growth of industry in a city, the success of a manufacturing process, or innovations in schools. Nothing grows (or diminishes) forever, and the machinery of growth often contains the seeds of its own limits.

System Dynamics has identified about a dozen different archetypes. Once we understand that a specific dynamic we’re describing is an example of an archetype, we can apply our general knowledge about that archetype to the situation at hand. Most significantly, we can identify areas of “leverage” where a small effort can have large results.

In Limits to Growth patterns, like the one above, leverage almost always lies in reducing the impact of the balancing structure, often by identifying constraints on resources. In this case, the resource constraint we’d be most curious about is the one contributing to student failure, and we’d anticipate that a leveraged response would increase a resource in a strategic way, so as to reduce student failure.

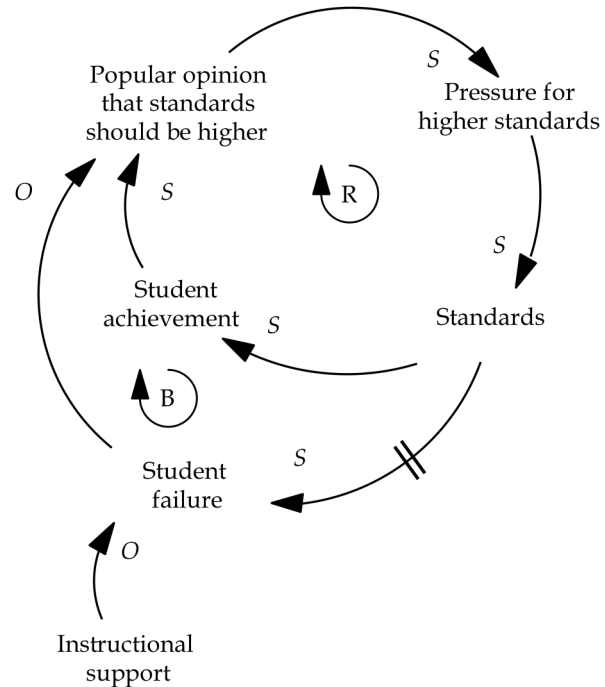
Interestingly enough, the solution the consultant suggested to his audience does exactly this. He suggested that the most effective way to respond to this dilemma would be to

anticipate the eventual student failures at the outset and therefore to put additional instructional supports in place at the same time that higher standards are adopted. We can capture this intervention on our System Dynamics Map this way:

### The Story (3)

*As instructional support increases, student failures decrease (the O indicates a trend in the opposite direction). As student failures decrease, opinion in favor of higher standards increases.*

### The System Dynamics Map



Putting instructional support in place effectively breaks the link between higher standards and student failures, and allows the positive momentum of the original cycle to continue, until it meets another limit to its growth.

Our experience is that System Dynamics Maps of this type are useful in at least three ways.

1. First, the process of creating the map requires people from different parts of the system to share their views about what's going on. In the case above, teachers, school administrators, parents, and even students would each tell their own version of the story. Collectively building a Systems Dynamics Map is usually the first time that people in the system acknowledge that differing points of view represent pieces of a more complete picture.
2. Second, the collective creation of a System Dynamics Map is often a significant breakthrough moment for participants. We often hear people say things like "Ah ... now I get it." Such moments lead to a movement away from blaming individuals and toward a recognition that all actors in the system are responding in rational ways. This is a key factor in getting people to consider how to cooperatively move the entire system toward its goal.
3. Finally, and most important, System Dynamics Maps allow us to identify the system leverage points – the things we can do that are likely to have big payoffs. In Limits to Growth structures like the one the consultant described, the leverage frequently lies in increasing capacity on the balancing side of the structure. The consultant's suggested solution, of augmenting instructional support to students

in danger of failing, illustrates perfectly how a general strategy like “increase capacity on the balancing side” finds concrete application in the real world.

1. Sterman J. D. (1989) *Modeling managerial behavior: Misperceptions of feedback in a dynamic decision experiment*, *Management Science*, 35, (3)

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To learn more about System Dynamics and System Dynamics Mapping we suggest...

- ◆ The Fifth Discipline Fieldbook, pages 91–161, Currency / Doubleday, New York (1994)
  - ◆ A Primer on Systems Thinking and Organizational Learning ([www.systemsprimer.com](http://www.systemsprimer.com))
  - ◆ The System Dynamics Mega-Link List ([www.uni-klu.ac.at/~gossimit/english.php](http://www.uni-klu.ac.at/~gossimit/english.php))
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