

# Overview of Systems Thinking

Daniel Aronson

**S**ystems thinking has its foundation in the field of system dynamics, founded in 1956 by MIT professor Jay Forrester. Professor Forrester recognized the need for a better way of testing new ideas about social systems, in the same way we can test ideas in engineering. Systems thinking allows people to make their understanding of social systems explicit and improve them in the same way that people can use engineering principles to make explicit and improve their understanding of mechanical systems.

## The Systems Thinking Approach

The approach of systems thinking is fundamentally different from that of traditional forms of analysis. Traditional analysis focuses on the separating the individual pieces of what is being studied; in fact, the word “analysis” actually comes from the root meaning “to break into constituent parts.” Systems thinking, in contrast, focuses on how the thing being studied interacts with the other constituents of the system—a set of elements that interact to produce behavior—of which it is a part. This means that instead of isolating smaller and smaller parts of the system being studied, systems thinking works by expanding its view to take into account larger and larger numbers of interactions as an issue is being studied. This results in sometimes strikingly different conclusions than those generated by traditional forms of analysis, especially when what is being studied is dynamically complex or has a great deal of feedback from other sources, internal or external.

The character of systems thinking makes it extremely effective on the most difficult types of problems to solve: those involving complex issues, those that depend a great deal dependence on the past or on the actions of others, and those

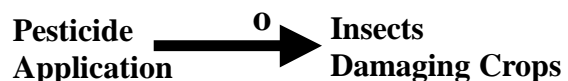
stemming from ineffective coordination among those involved. Examples of areas in which systems thinking has proven its value include:

- Complex problems that involve helping many actors see the “big picture” and not just their part of it
- Recurring problems or those that have been made worse by past attempts to fix them
- Issues where an action affects (or is affected by) the environment surrounding the issue, either the natural environment or the competitive environment
- Problems whose solutions are not obvious

## Use of Systems Thinking

An example that illustrates the difference between the systems thinking perspective and the perspective taken by traditional forms of analysis is the action taken to reduce crop damage by insects. When an insect is eating a crop, the conventional response is to spray the crop with a pesticide designed to kill that insect. Putting aside the limited effectiveness of some pesticides and the water and soil pollution they can cause, imagine a perfect pesticide that kills all of the insects against which it is used and which has no side effects on air, water, or soil. Is using this pesticide likely to make the farmer or company whose crops are being eaten better off?

If we represent the thinking used by those applying the pesticides, it would look like this:



*(Reading the Diagram:* The arrow indicates the direction of causation - that is, a change in the amount of pesticide applied causes a change in the numbers of insects damaging crops. The letter indicates how the two variables are related: an “s” means they change in the same direction - if one goes up then the other goes up, and an “o” means they change in the opposite direction - if one goes up then the other goes down (or vice versa). This diagram is read “a change in the amount of pesticide applied causes the number of insects damaging crops to change in the opposite direction.” The belief being represented here is that “as the amount of pesticide applied increases, the number of insects damaging crops decreases.”)

According to this way of thinking, the more pesticide is applied, the fewer insects there will be damaging crops, and the less total crop damage.

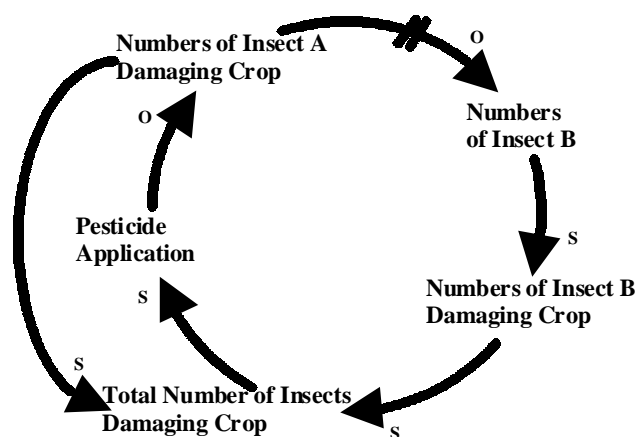
The temptation is to say that eliminating the insects eating the crops will solve the problem; however that often turns out to not be the case. The problem of crop damage due to insects often does get better - in the short term. Unfortunately, the view diagrammed above represents only part of the picture. What frequently happens is that in following years the problem of crop damage gets worse and worse and the pesticide that formerly seemed so effective does not seem to help anymore.

This is because the insect that was eating the crops was controlling the population of another insect, either by preying on it or by competing with it. When the pesticide kills the insects that were eating the crops, it eliminates the control that those insects were applying on the population of the other insects. Then the population of the insects that were being controlled explodes and they cause

more damage than the insects killed by the pesticide used to.

In other words, the action intended to solve the problem actually makes it worse because the way its unintended side effects change the system ends up exacerbating the problem.

In fact, some studies suggest that a majority of the 25 insects that cause the most crop damage each year became problems to begin with because of exactly this cycle. Graphically, the way this happens can be represented as:



According to this understanding, the greater the pesticide application, the smaller the numbers of Insect A (the original pest) that will eat the crop. This leads to an immediate decrease in the numbers of insects eating the crop (note that this is the effect those applying the pesticides are intending). However, the smaller numbers of insect A eventually lead to greater numbers of Insect B (the hash marks on the arrow indicate a delay), because insect A is no longer controlling the numbers of insect B to the same extent. This leads to a population explosion of insect B, to greater numbers of insect B damaging crops, and to greater numbers of insects damaging the crop, exactly the opposite of what was intended. Thus, although the short-term effects of applying the

pesticide were exactly what was intended, the long-term effects were quite different.

With this picture of the system in mind, other actions with better long-term results have been developed, such as Integrated Pest Management, which includes controlling the insect eating the crops by introducing more of its predators into the area. These methods have been proven effective in studies conducted by MIT, the National Academy of Sciences, and others, and they also avoid running the risk of soil and water pollution.

The way that the broader perspective of systems thinking creates the understanding necessary for better long-term solutions was also evident in work I did with a company whose industry was being deregulated. They seemed to be doing everything right in working on a customer-relations problem they were experiencing: they had a team of capable people working on it, they were using a process that had been successful many times in the past, and they even had affected customers giving them feedback on proposals to rectify the situation.

However, they were having difficulty seeing the big picture of how the way they historically did things was contributing to the problem. Working together over two days, I was able to help them see how the problem was being exacerbated and the most powerful actions they could take to solve it. The session ended with the creation of a strategy for addressing the problem that was unanimously supported by the team and the customers.

By seeing the whole picture, the team was able to think of new possibilities that they had not come up with previously, in spite of their best efforts. Systems thinking has the power to help teams

create insights like these, when applied well to a suitable problem.

(Other examples of positive results obtained by systems thinking in service, human resources, and high-technology industries can be found in Peter Senge's classic *The Fifth Discipline* and in The Systems Thinker newsletter, published by Pegasus Communications.<sup>i)</sup>)

## **A Better Way to Deal with Our Most Difficult Problems**

So many important problems that plague us today are complex, involve multiple actors, and are at least partly the result of past actions that were taken to alleviate them. Dealing with such problems is notoriously difficult and the results of conventional solutions are often poor enough to create discouragement about the prospects of ever effectively addressing them. One of the key benefits of systems thinking is its ability to deal effectively with just these types of problems and to raise our thinking to the level at which we create the results we want as individuals and organizations even in those difficult situations marked by complexity, great numbers of interactions, and the absence or ineffectiveness of immediately apparent solutions.

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Daniel Aronson is the host of the *Thinking Page* (<http://www.thinking.net>)

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<sup>i</sup> Senge, Peter, *The Fifth Discipline* NY: Currency/Doubleday, 1990

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