

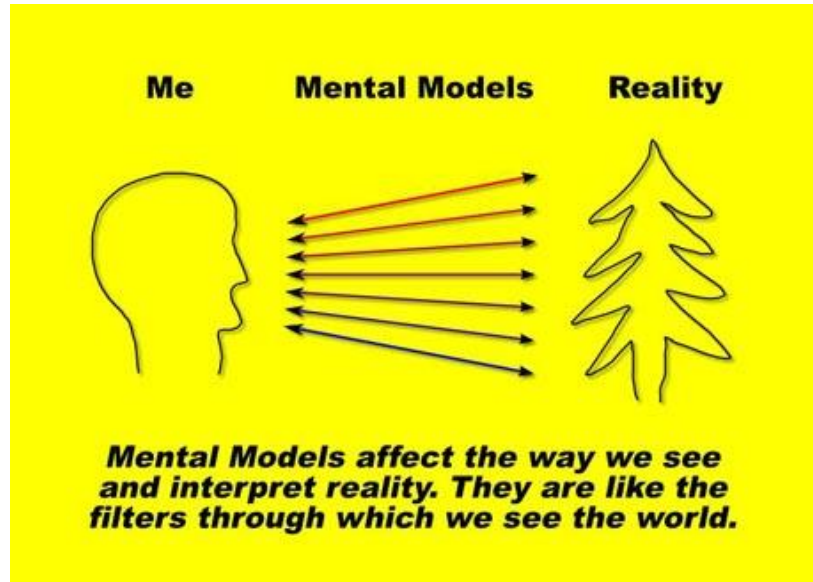
Why Systems Thinking?

Everyone wants to make good decisions. All our lives, our decisions affect how our lives will be, how they will affect our quality of life. But a lot of our decisions don't work out the way we expect. Why is that?

We base every decision on our mental models of how the world works, or at least how that part works that is the target of our decision. Mental models are the images, assumptions and stories which we carry in our minds of ourselves, other people, institutions, and every aspect of the world. Like a pane of glass framing and subtly distorting our vision, mental models determine what we see...they are cognitive mental maps; and all of those maps - by definition - are flawed in some way.



MENTAL MODELS ARE DEEPLY HELD INTERNAL IMAGES OF HOW THE WORLD WORKS, IMAGES THAT LIMIT US TO FAMILIAR WAYS OF THINKING AND ACTING. VERY OFTEN, WE ARE NOT CONSIOSLY AWARE OF OUR MENTAL MODELS OR THE EFFECTS THEY HAVE ON OUR BEHAVIOUR.

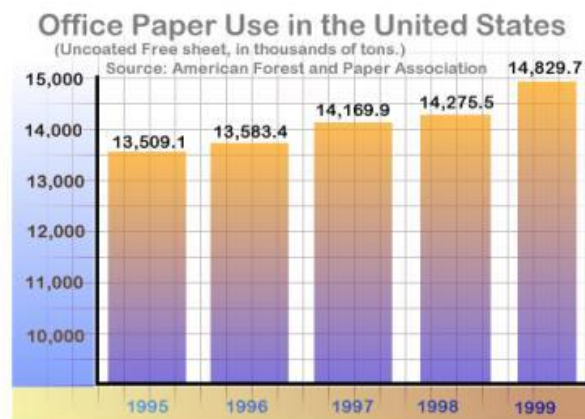


To compound the problem, we don't think consciously about the mental model that governs a decision! And that really is a problem, because often our mental models are very limiting - very "small" - often more based on wishful thinking than an objective assessment of reality - and so the resulting decisions lead to unexpected and unwanted consequences.

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Let's look at these examples of decisions that seemed like miracle "solutions" at the time, but turned out to have quite counter-intuitive consequences:

Information technology has not enabled the "paperless office" - paper consumption per capita is UP.



Road building programs designed to reduce congestion have **INCREASED** traffic, delays and pollution.

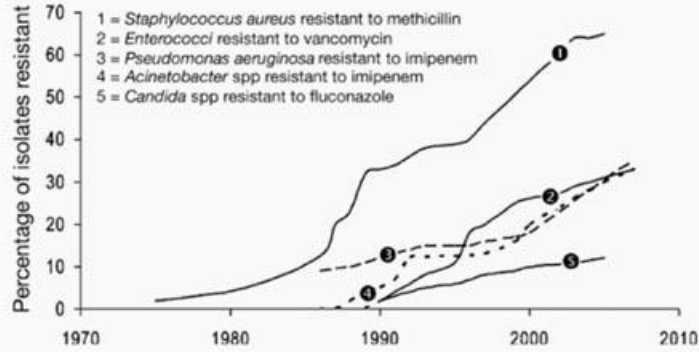


Despite widespread use of labor saving appliances, American have **LESS** leisure today than 50 years ago.

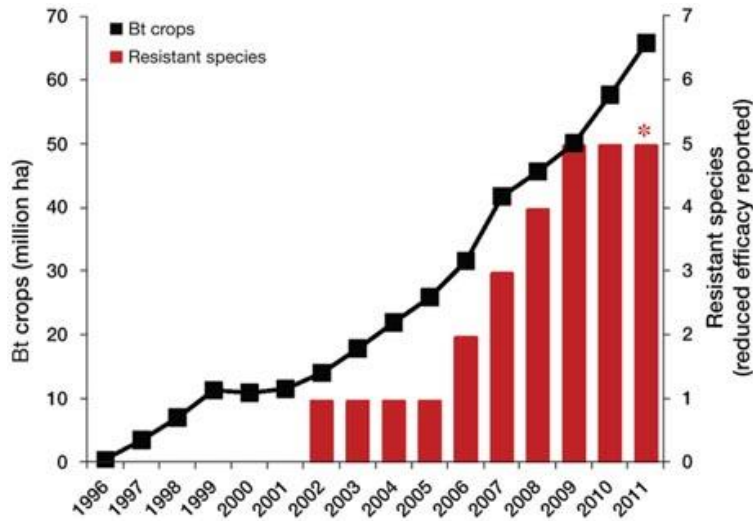


Antibiotics have **STIMULATED** the evolution of drug-resistant pathogens, including virulent strains of TB, strep, staph and sexually transmitted diseases.

Antimicrobial Resistance for Selected Pathogens over Time



Pesticides and herbicides have **STIMULATED** the evolution of resistant pests and weeds, killed off natural predators, and accumulated up the food chain to poison fish, birds and possibly humans.



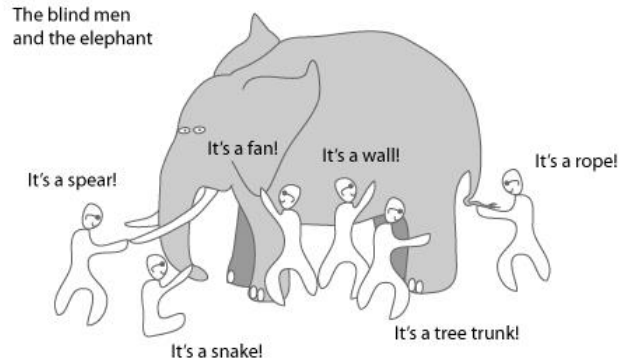
A system of unrestrained free trade generates monopolies that **CONTROL** trade.



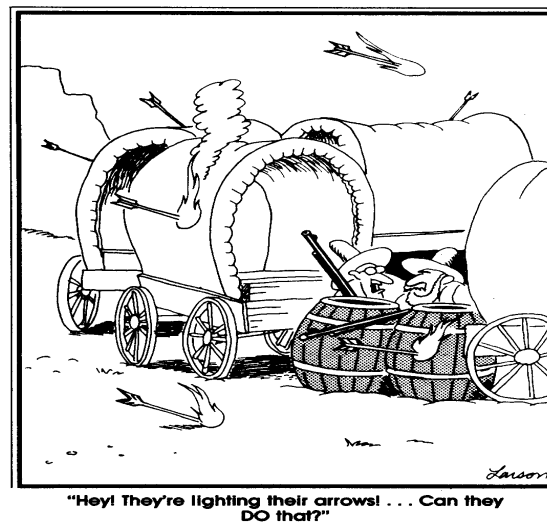
We inhabit a world that is a complex of interconnected parts. Because of the interconnections, the parts influence one another: they are often interdependent, so that change in one part can ripple out in many directions like a pebble thrown into a pond. In other words, we live in a systemic world. Therefore most every situation that we want to manage with our decisions requires us to consider many interdependent elements. So a good mental model to govern a decision requires us to discover the cluster of elements or variables that is going to affect or be affected by that decision. In systems thinking we call that discovery the **system of influence**.

We need to look critically at our mental models because our conventional culture and schooling have typically trained us to focus too narrowly and see only parts of the **system of influence**.

Every problem or situation that we want to understand requires that we discover a system of influence that is specific to it. A doctor who arbitrarily takes the body as the system of influence may explain a breathing problem as a constriction in the respiratory system, and diagnose the problem as asthma. But a good doctor will consider potential environmental causes beyond the body. If air pollution and a poorly regulated industry is discovered to be the ultimate cause, then the system of influence for that problem may extend as far as a governmental system that allows air pollution.



Or, sometimes our mental models are based on wrong assumptions about how the system works. So we get stuck in our mental models following rules that don't really exist.



Alternatively, our mental model may ignore rules that do exist. Many economists assume that natural resources consumed in an economy are infinitely substitutable, and that resource consumption is not an economic problem. But according to the laws of nature, many resources are finite, and economies that rely on them are courting failure. Or, our mental models have too small a time frame; they don't look at how the situation might change over time. The way we do science has produced a focus on immediate results. Consider the invention of invention of synthetic nitrogen fertilizer:

Energy Intensive Nitrogen Fertilizer

Immediate consequence: higher crop production and tripling of world population.

Medium term consequences:

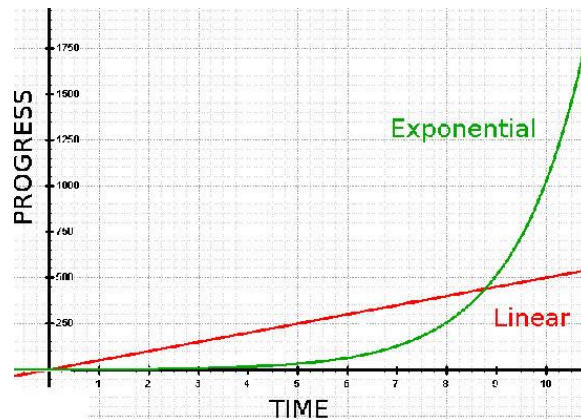
- Soil microbe decimation, leading to:
 - Poor plant health
 - Increased pesticide use

- Increased pesticide use, leading to:
 - More soil foodweb decimation, imbalanced plant nutrition
 - Compacted soil
- Plant diet imbalance, leading to
 - Lower plant health
 - Declining nutritional value of food products
- Soil compaction, leading to
 - Poor plant and soil foodweb health
 - Increased energy expended in tillage

Long term consequences:

- Depletion of fossil energy, leading to:
 - Rising fertilizer costs
 - Failure of industrial agriculture
 - Declining world population

We need models that capture the complexity in a way that helps us understand the behavior in the situation that we want to manage with our decisions. We need mental models that describe the connections. The complexity that is important to understand is in the dynamics: how things change over time. We tend to assume that change is regular, such that it appears as a straight line (linear) in a time graph, whereas often change is nonlinear in our world, and that surprises us, and often it is an unhappy surprise. For example we may think of unpaid debt as accumulating linearly, as in the red line in the graph. But debt at any interest rate above zero rises exponentially, as in the green line.



Because it is the causal connections that generate the often unexpected behavior over time, we need models that capture the important causal connections that influence a situation. Systems thinking teaches us to construct *visual* models that help us see the causal relations and make better decisions.

From this initial discussion of mental models what can we conclude about how to improve them?

- Build models of processes, not static snapshots of the world
- Enlarge our perspective to include the structures that generate the behaviors we are trying to understand: discover the fullest *system of influence*
- Create visible models – graphics to capture systemic, causal structures, instead of verbal models that are linear

Later lessons in this course will provide tools to achieve these goals.

