Systems Thinking "Review Sheet"

Systems Thinking: Understanding a whole by examining it's parts and their interrelationships.

Purpose of Systems Thinking

- Understand our systems; to create meaningful explanations for *why* and *how* things happen the way they do... Or don't... In order to open new avenues for getting the results we want.
- Provide a language for communication among a team examining a system.
- Provide a language for communicating results of such examinations to others.
- …in order to find higher leverage actions to get the results we want.

Uses of Systems Thinking

- Driven by a challenge, to find helpful insights.
- Starting from a specific experience, to learn from it.
- In the moment.
- For a "Greenfield" situation.

Starting Point

The starting point is some measure of interest, shown in a graph vs. time...
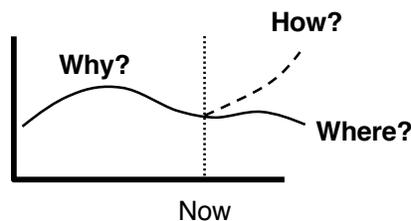
Systems Thinking Addresses 3 Key Questions:

- Why? — Why has this measure followed the course it has traced?
- Where? — Where is it likely to go if things continue as they are now?
- How? — How can we get the result we desire?
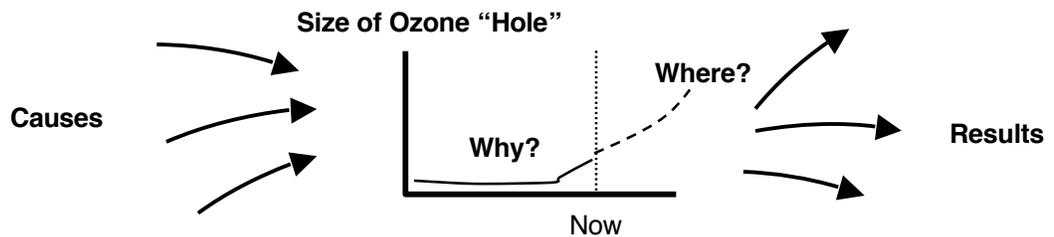
Diagramming for Analysis
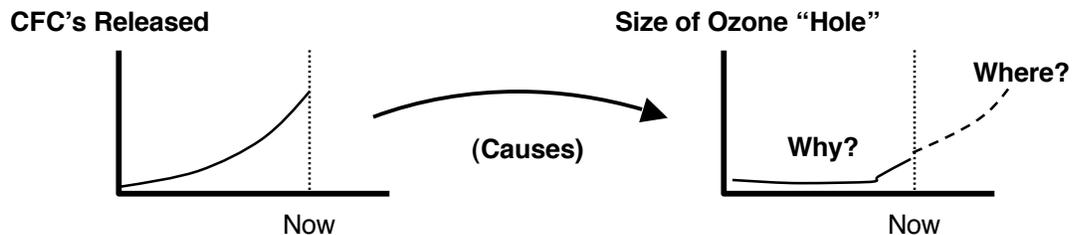
1. Variables

Anything you can graph vs. time.

Size of Ozone "Hole"

Where?

Why?

Now
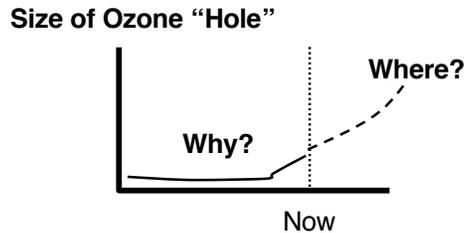
Note: Choose an *appropriate* time frame for each graph.

2. Causal Connections

Start with any variable of interest. Consider Causes… and Results

Size of Ozone "Hole"

Causes

Where?

Why?

Now

Results

Connect graphs to show causal connections. Change in
_____ causes a change in _____.

CFC's Released

Size of Ozone "Hole"

Now

(Causes)

Where?

Why?

Now

Connect the causal chains forward… and backward… far
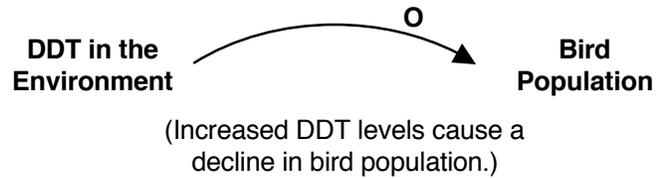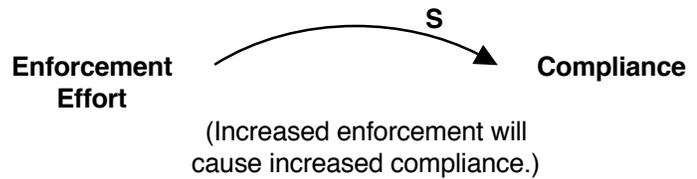enough to cover the important elements.

Diagramming (Continued)

3. Sense of Causal Connections

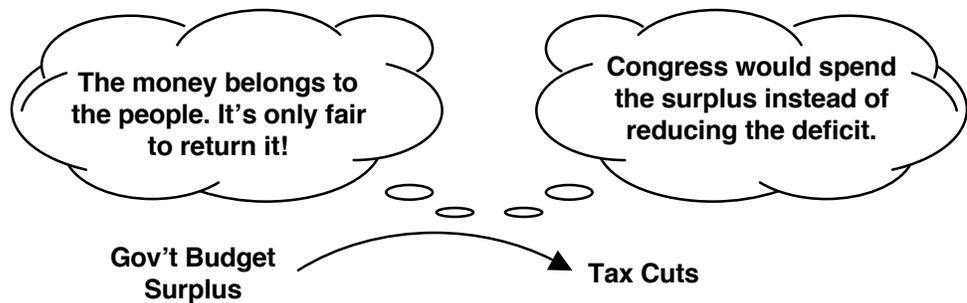Each link shows "Change causes change."

Mark each link with:

"S" when changes in SAME direction
"0" when opposite

Enforcement Effort ⟶ **S** ⟶ **Compliance**

(Increased enforcement will cause increased compliance.)

DDT in the Environment ⟶ **O** ⟶ **Bird Population**

(Increased DDT levels cause a decline in bird population.)

4. Look for Mental Models

When the result is a human choice, look for the thinking that leads to the choices being made. Note the thinking in a "Thought Bubble."

The money belongs to the people. It's only fair to return it!

Congress would spend the surplus instead of reducing the deficit.

Gov't Budget Surplus ⟶ **Tax Cuts**

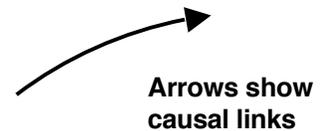(Of course, different people may have different opinions about this!)

Diagramming (Continued)

5. Watch for Things that Accumulate

Things that accumulate…
- Can only change by flows in… and out.
- Cannot be changed instantly
- We call these "Resources" or "Stocks"

Examples:
- Amount of water in a bathtub or pool.
- Level of skills or knowledge or ability.
- Amount of "green-house gases" in atmosphere.

Resource

Where?

Why?

Now

In-flowing　　　　**Out-flowing**

In-flowing　　　　**Pipes show flows**

Ordinary Variable

Why?

Where?

Now

Arrows show causal links
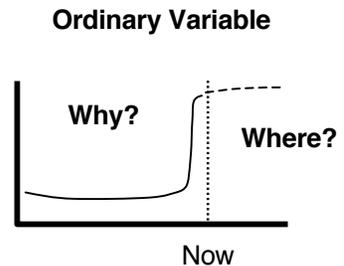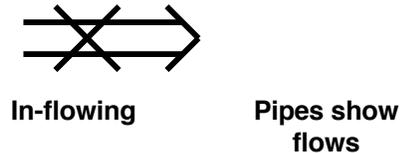
6. Draw Causal links *from* resources and *to* flows.

Use arrows to make causal links *from* resources… and *to* flows… These are just like the causal links between ordinary variables.

For example, consider green-house gases (like CO_2) and Global Warming:
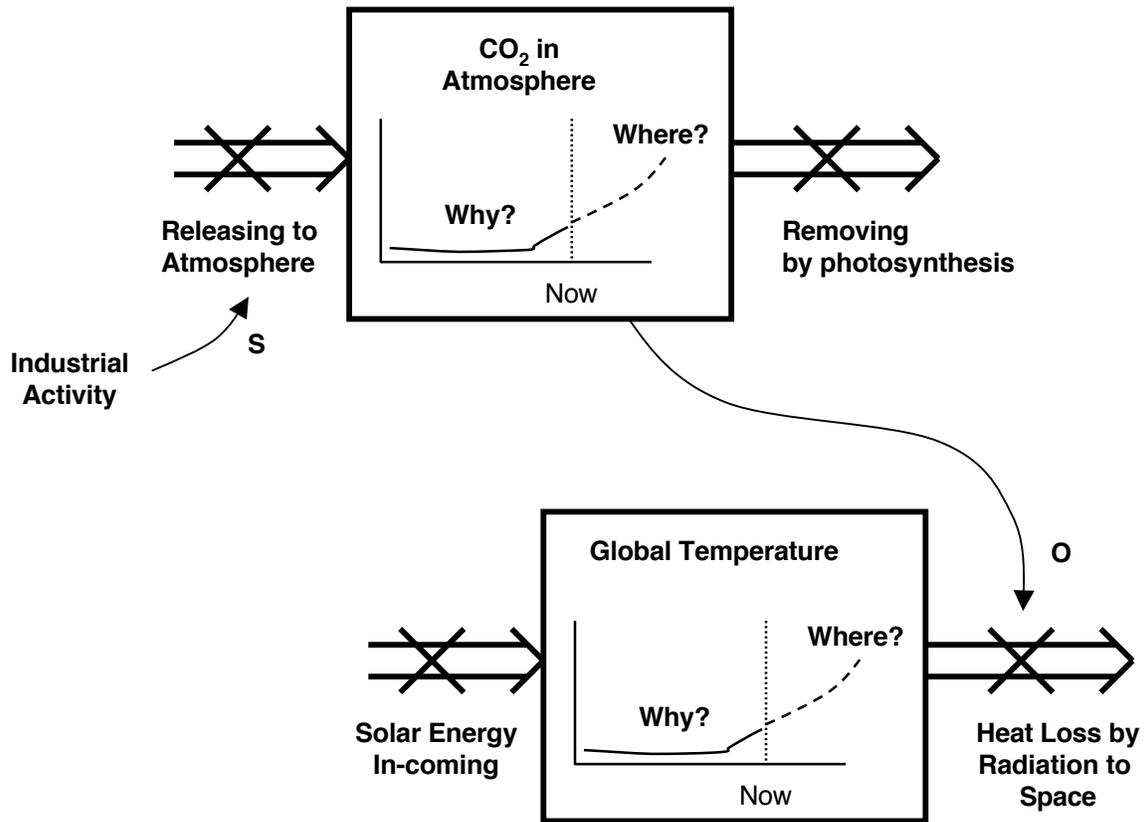
Explanation:
- Increasing Industrial Activity causes increasing releases of CO_2.
- CO_2 accumulates in the atmosphere. It is removed slowly.
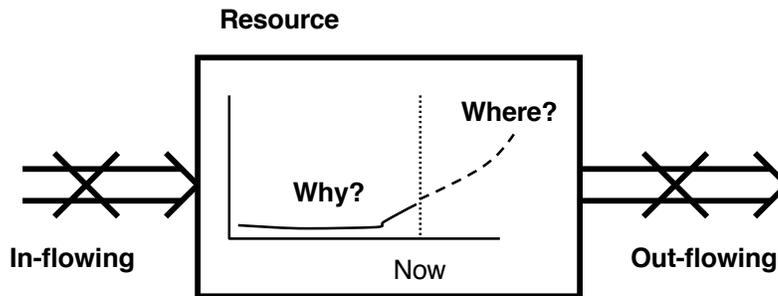- The more CO_2 in the atmosphere the less heat loss by radiation from Earth to space, therefore increasing the Global Temperature.

Diagramming (Continued)

7. Look for Loops

Tracing the chains of cause and effect, look for closed loops. When you find a loop, characterize it as "Reinforcing" or "Balancing."

Reinforcing Loop

US Weapons Spending **R** Russian Weapons Spending

S

S

Balancing Loop

Target Speed

Actual Speed

S

O **S**

B

Delay

Shortfall vs. Target

Pressure on Gas Pedal **S**

Engineering: **Positive Feedback**	**Negative Feedback**
Systems Thinking: **Reinforcing Loop**	**Balancing Loop**
Behavior: **Run-Away**	**Control, Stability**
	(May Oscillate)

8. Completing a Diagram

Two approaches to completing a diagram… Trace the chains, or try to fit one of the System Archetypes (see notebook).

Review Systems Archetypes – See which seem to fit — **OR** — Trace the chains of cause & effect

Draw the Loop Diagram

Close the core loop; Add other loops

9. Testing a Diagram

Does the diagram explain the behavior of interest?