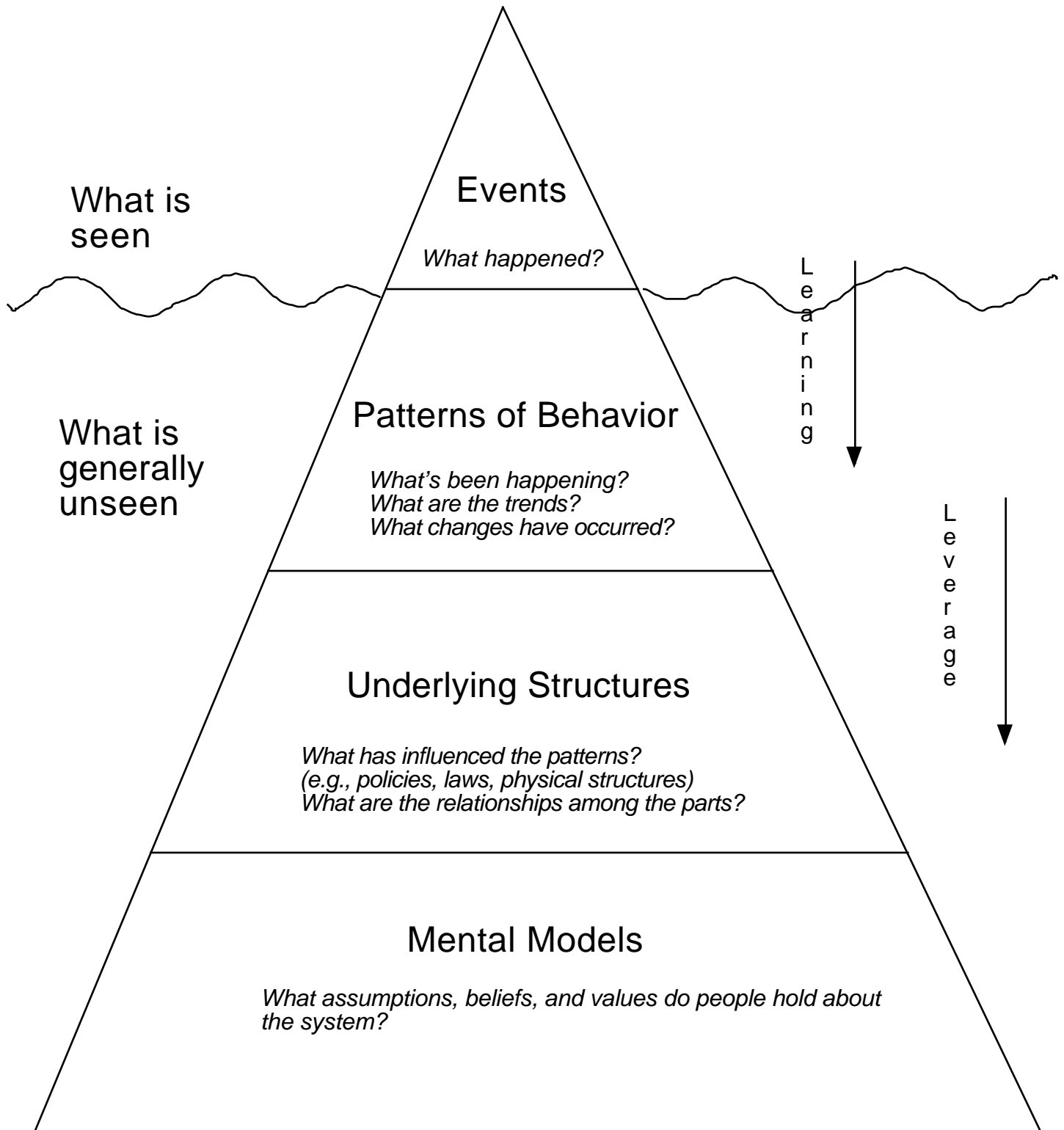
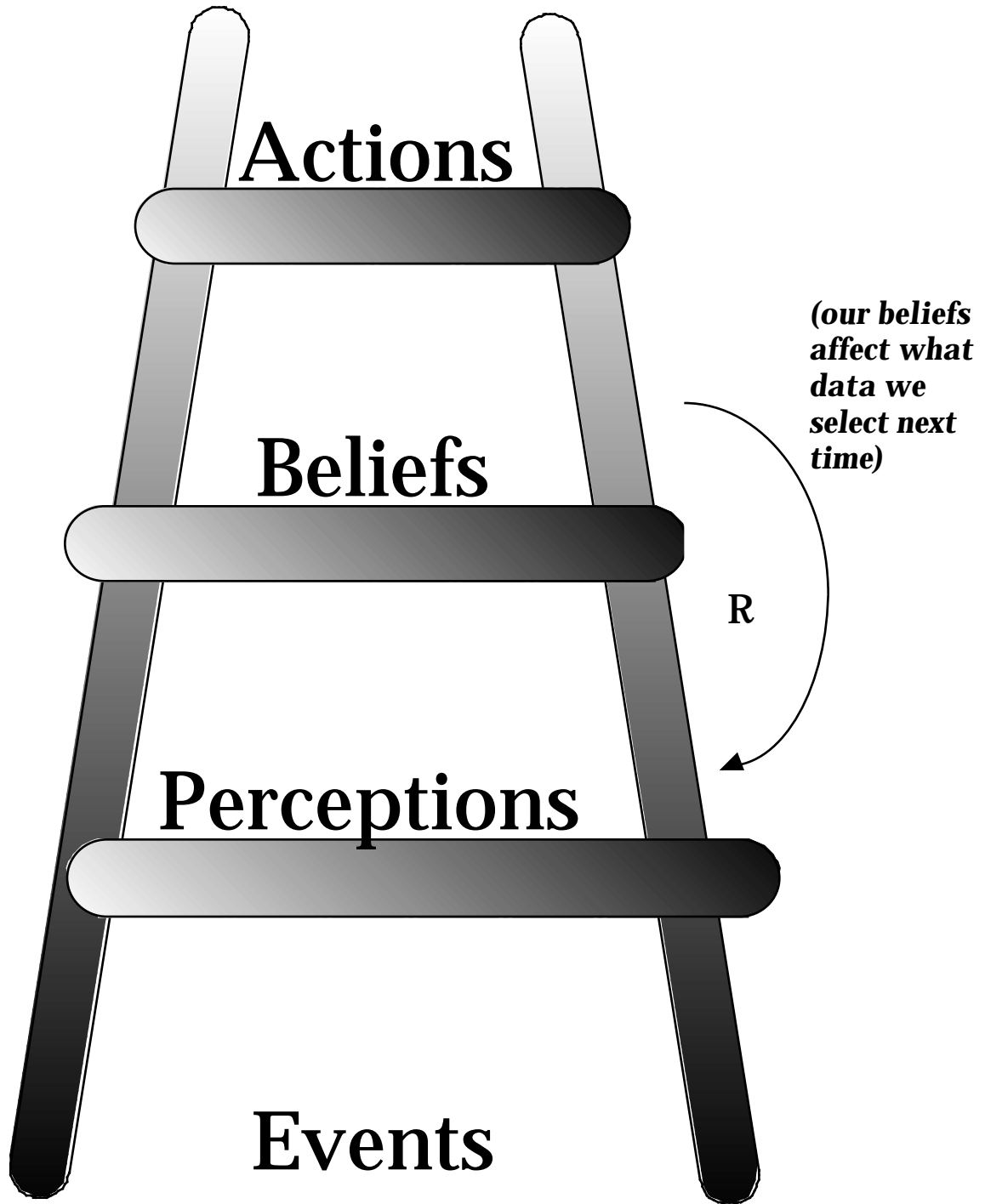


Iceberg...Seeing What's Below the Surface

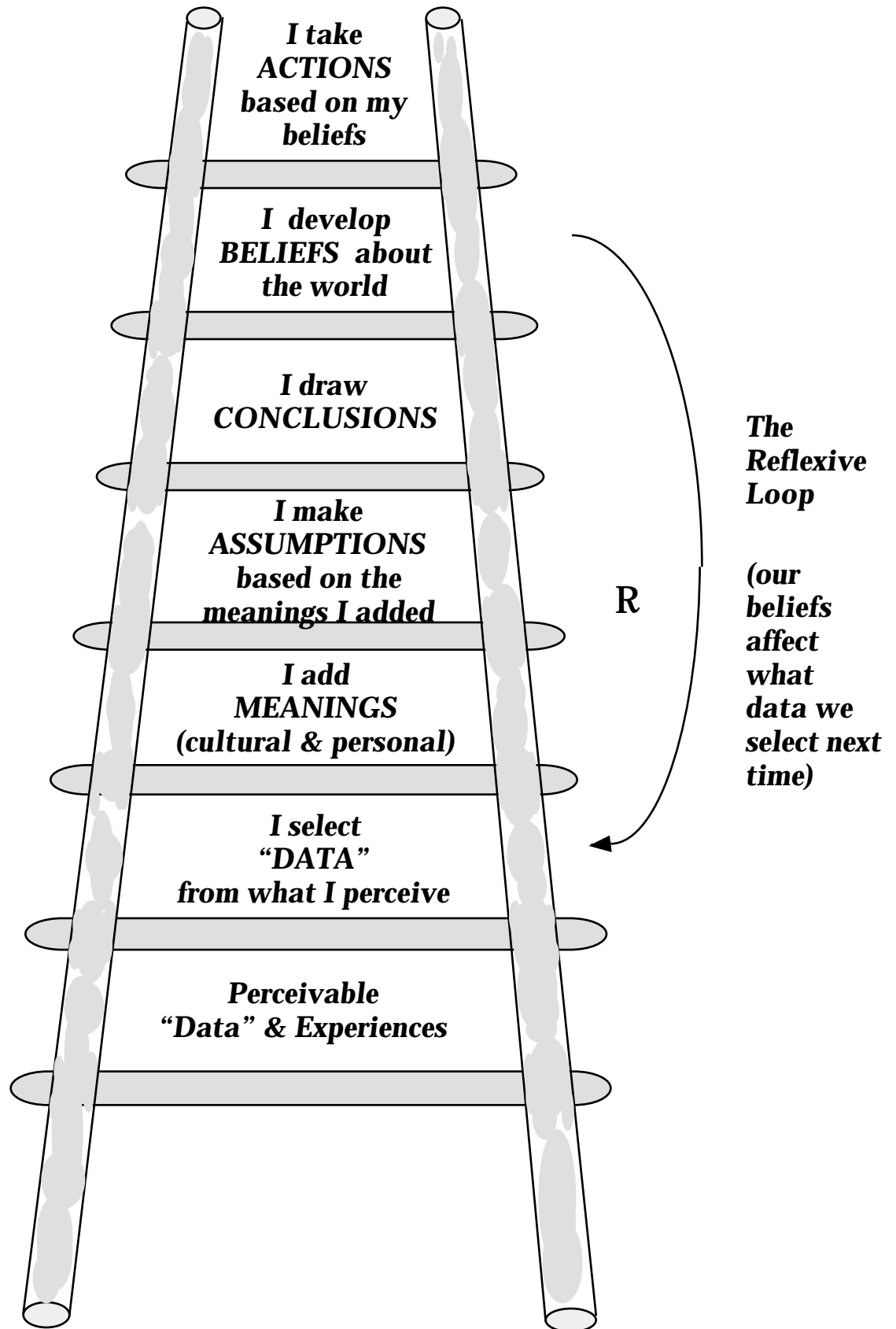


Simple Ladder of Inference



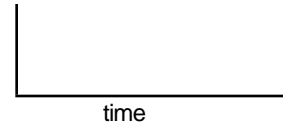
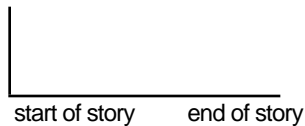
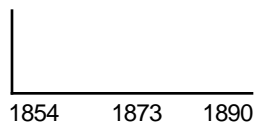
Adapted from The Fifth Discipline Fieldbook by Peter Senge et.al

Ladder of Inference

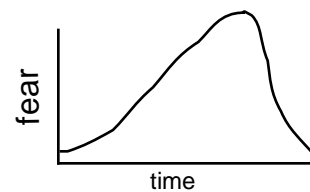
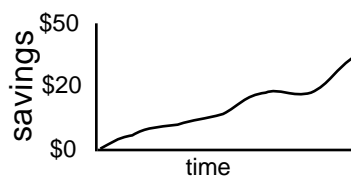
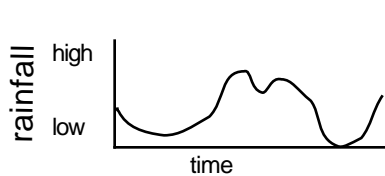


Tips for Behavior-Over-Time-Graphs (BOTGs)

1. A BOTG shows the trend, or pattern of change, of a variable over time as opposed to discrete events.
2. On a basic line graph that is a BOTG:
 - the X axis is always labeled time
 - the X axis' beginning, medial, and ending times may be indicated or not, depending on your purpose:



3. The Y axis:
 - indicates the variable being graphed and must be labeled with that variable's name
 - label is particularly important when looking at graphs of different variables
 - should not include qualitative words such as more, less, increasing, bigger, etc. in the variable's name; it's difficult to understand less "More fear" over time
 - variable being graphed may be "hard" (like population or temperature) or "soft" (like love or stress)
 - may be quantified as much or little as possible, or not at all:



4. If students/staff choose to graph more than one variable on the same graph, they will need to differentiate between the lines on the graph by including a key of some sort.
5. Different interpretations of the stated variable are definitely possible, although generally peoples' graphs of the same variable will look fairly similar. If they are radically different, discussion of the differences should take place, and could be very interesting!
6. Discussion of when and where a trend or pattern of behavior starts, ends, or changes direction is recommended.
7. When discussing the graphs of different variables, the graphs could be compared for possible interdependencies and causal relationships between the variables.

Waters Grant Project '97

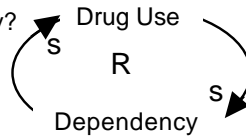
Catalina Foothills School District, 1911 E. Orange Grove Road, Tucson, AZ 85718

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Tips for Causal Loop Diagrams (CLDs)

- CLDs show causal relationships and illustrate circular feedback within a system.
A cause becomes an effect, becomes a cause, becomes an effect, and so on.

- Does an effect in turn become a cause either directly or indirectly?
You should be able to read the loop around several times (does more drug use lead to more dependency, which leads to more drug use, etc.?).



- You may choose to begin by creating behavior-over-time graphs (BOTGs) based upon information found in any given source.

Since CLDs are about the causes of change, it is often helpful to identify how key elements actually did change.

- All variables in a CLD must be able to increase or decrease.

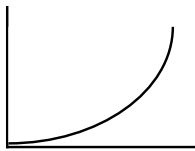
Choosing your terms for the elements is one of the challenges of creating CLDs. For example, "Feelings" is a nebulous term for a loop...what does an increase in feelings really mean? Try "happiness," "sadness," or "frustration" instead.

- Find a focus for the loop(s) from the identified BOTGs or directly from the given source. Pick an aspect A that makes another aspect B increase or decrease, which comes back to make A increase or decrease (the loop can also include aspects C, D, etc.).

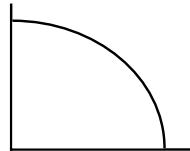
Who is the audience? What is the purpose of your loop(s)? Pick one aspect of the system. Focus on a behavior that is changing over time...what are the causes? This/these become the other aspects of the loop(s).

- Remember "s" means a change in the same direction...not necessarily an increase.
Remember "o" means a change in the opposite direction...not necessarily a decrease.

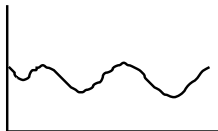
- Reinforcing loops grow more and more (get better and better) or decline more and more (get worse and worse).



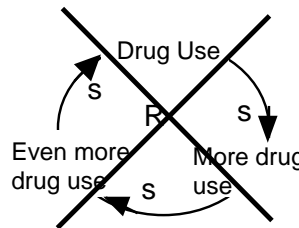
or



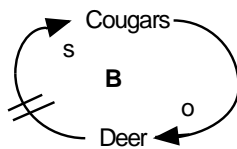
Balancing loops oscillate.



- Do not use the same variable more than once in your diagram.
- Do not use words such as more/less, increases/decreases as part of the variable name.



- If there is a significant amount of time between one variable and the next variable in the loop, a time delay can be indicated by drawing two short parallel line segments across the arrow that connects those two variables.



- Potential variables for CLDs are not always included within the scope of a given source.

Causality may be linear within the scope of the given source, but you might know of, or be able to hypothesize, information beyond the information supplied which might let you identify circular causality.

Tips for Stock/Flow Diagrams/Maps

1. **Stock/Flow Diagrams or Maps** show interdependencies and feedback within a system by identifying major accumulations and the factors that increase and decrease them over time.

2. Definitions:



• **stock**- represents an accumulation, concrete or abstract, that increases or decreases over time; the “noun(s)” in the system



• **flow**- represents actions or processes; transports “stuff”, concrete or abstract, that directly adds to or takes away from the accumulation in a stock; can be either an inflow or an outflow; the “verb(s)” in the system



• **converter**- holds information or relationships that affect the rate of the flows, or that affect the content of another converter



• **connector**- indicates that changes in one element cause changes in another element; only changes a stock by going through an accompanying flow

3. Depending on the group, you may want to explain and draw this “bathtub analogy” before mapping:

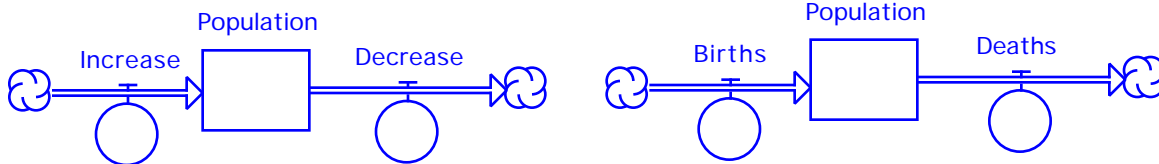
- a stock is like a bathtub which can be filled or drained
- an inflow is like a pipe that goes into the stock (tub) and fills it according to how much the spigot on the pipe (inflow) is opened/closed
- an outflow is like the drain that allows the accumulation to flow out according to how much the drain spigot (outflow) is opened/closed
- a converter is like a wrench that adjusts the spigot on a flow by way of the connector

4. For group mapping, you may choose to draw the map freehand and display it, or use the STELLA program and project it.

5a. One way to generate possible **stocks** to use in a map is to have the group create and discuss BOTGs from the article/story/information under consideration, then choose the BOTG(s) they wish to study as the stock(s) in the map (perhaps the most important accumulations). *

b. Another way is simply to choose the stocks you wish to emphasize ahead of time, making sure at some point to have the group create the BOTG that represents the trend of each stock’s accumulation/drain over time.

6. The **inflow** and **outflow** can be labeled simply as “Increase” and “Decrease” or as concrete or abstract “stuff” flowing into and/or out of the stock. The unit of measure used for the stock must also be used to measure the inflow and outflow. Remember: if you stop time in the system, nothing will remain in the flows, but the accumulation will remain in the stock.



7. **Converters** may be chosen from the remaining BOTGs generated in 5a above, or directly from the article/story/information. It is sometimes helpful to aggregate information in converters, e.g. tornado, fire, flooding, and earthquake could be aggregated in a converter labeled “natural disasters.”

8. A **connector** must point to the element that is being affected.

9. Once you have set up your stock(s), flows, converters, and connectors, make sure you look for the **feedback** that makes a system dynamic! Ask questions such as: Does the accumulation in the stock affect its inflow? outflow? converters? other stocks’ inflow/outflow/converters?

* When choosing a name for any element in a S/F map, try to keep words like “more” and “less” out of the name; e.g. “Level of Stress” is preferable to “More Stress”.