# Introduction to Systems Thinking for Early Childhood Leaders

## CEELO Leadership Academy
### Washington D.C.
### February 10 - 11, 2016

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CEELO
Center on Enhancing Early Learning Outcomes

Waters Foundation
Systems Thinking in Education

**CEELO Leadership Institute- 2016**
**Introduction to Systems Thinking**

Session Learning Goals

1. Fellows will be able to identify ways Systems Thinking habits and tools can **positively influence and impact leadership and program development**.
2. Fellows will be able to identify ways Systems Thinking habits and tools apply to **job-embedded projects and the role of state level leadership**.
3. After the 2-day session, Fellows will leave with concrete ways systems thinking tools and strategies can be applied to **leadership work**.

Expected Capacity-building Outcomes

1. Increase understanding of how mental models are developed overtime (Mental models are deeply ingrained assumptions that influence how we understand the world and how we take action.)
2. Investigate ways to understand and utilize the diverse perspectives people hold about systems of interest
3. Identify the causal interdependencies that influence the behavior of systems
4. Develop insights about short-term, long-term and unintended consequences of decisions and actions.
5. When working to achieve desired outcomes, discover ways to move from siloed efforts to cohesive, systemic approaches
6. Build skill in identifying and mapping essential, interdependent system components

**Agenda Overview**

Day 1
Introduction and Check-in
Framing the 2 day session
Debrief Homework
Characteristics of Complex Systems
Importance of an Endogenous View
Habits of a Systems Thinker
Systems Thinking Tool Overview
Mental Models and The Ladder of Inference
Systems Thinking Iceberg
Recognizing Patterns and Trends using Behavior-over-Time graphs

Day 2
Understanding interdependence in complex systems
Connection Circles
Casual Feedback: Reinforcing and Balancing
Loops show interdependence and tell stories: Casual Loop Archetypes
Iceberg completion and peer coaching
Revisit Habits of a System thinker
You know you are s systems thinker if you pay attention to…
Closure

## Characteristics of a System

All systems have boundaries. Most systems have subsystems that are nested and interconnected.

For example, schools are subsystems of school districts and classrooms are subsystems of schools.

### Systems also have:

**Elements or Parts**
Examples include people, policies and resources.

**Interconnections or Relationships among the Parts**
A system consists of interconnected parts. The word "interdependence" is sometimes used to describe system relationships.

**Dynamics**
Systems tend not to stand still and continually change and adjust over time.

**Goal or Purpose**
All systems have goals or purposes. Some goals are explicit and others are implicit.

## The Importance of an Endogenous View

*Your system…any system is perfectly designed to produce the results you are obtaining.* (Adapted from Carr, 2008)

An Endogenous View
Produced, originated or growing from within; having a cause internal to the system

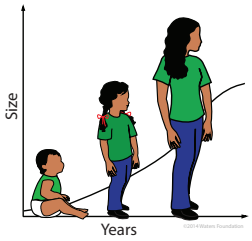
An endogenous view (a systems that can view itself internally) helps one see what influences the behavior of the system, and helps one avoid the blaming of others when things go wrong.

When things are not going well in systems, an endogenous view helps people fully examine the internal causes that influence the system's ill behavior.

This perspective creates a rich environment for productive decision-making and improvement.

Seeks to understand the big picture

Observes how elements within systems change over time, generating patterns and trends

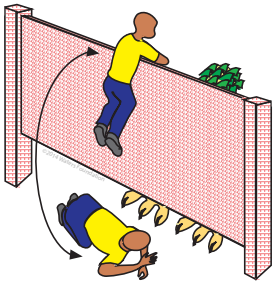



Recognizes that a system's structure generates its behavior

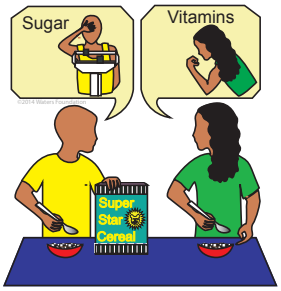
Identifies the circular nature of complex cause and effect relationships

Makes meaningful connections within and between systems

Changes perspectives to increase understanding



Surfaces and tests assumptions




## Habits of a Systems Thinker

Considers an issue fully and resists the urge to come to a quick conclusion

Considers how mental models affect current reality and the future

Uses understanding of system structure to identify possible leverage actions

Considers short-term, long-term and unintended consequences of actions

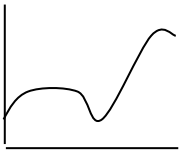

Pays attention to accumulations and their rates of change

Recognizes the impact of time delays when exploring cause and effect relationships

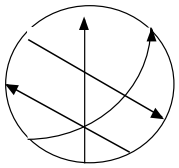
Checks results and changes actions if needed: "successive approximation"

## The Visual Tools of Systems Thinking

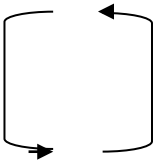
The visual tools of systems thinking provide dynamic ways to engage in critical thinking, problem solving and deeper learning.



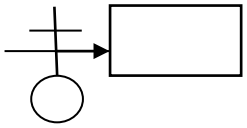
Behavior-Over-Time Graph



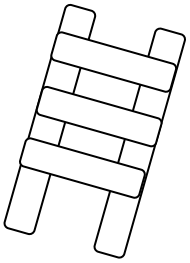
Connection Circle



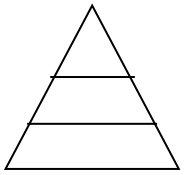
Causal Loop Diagram
or Feedback Loop



Stock and Flow Diagram

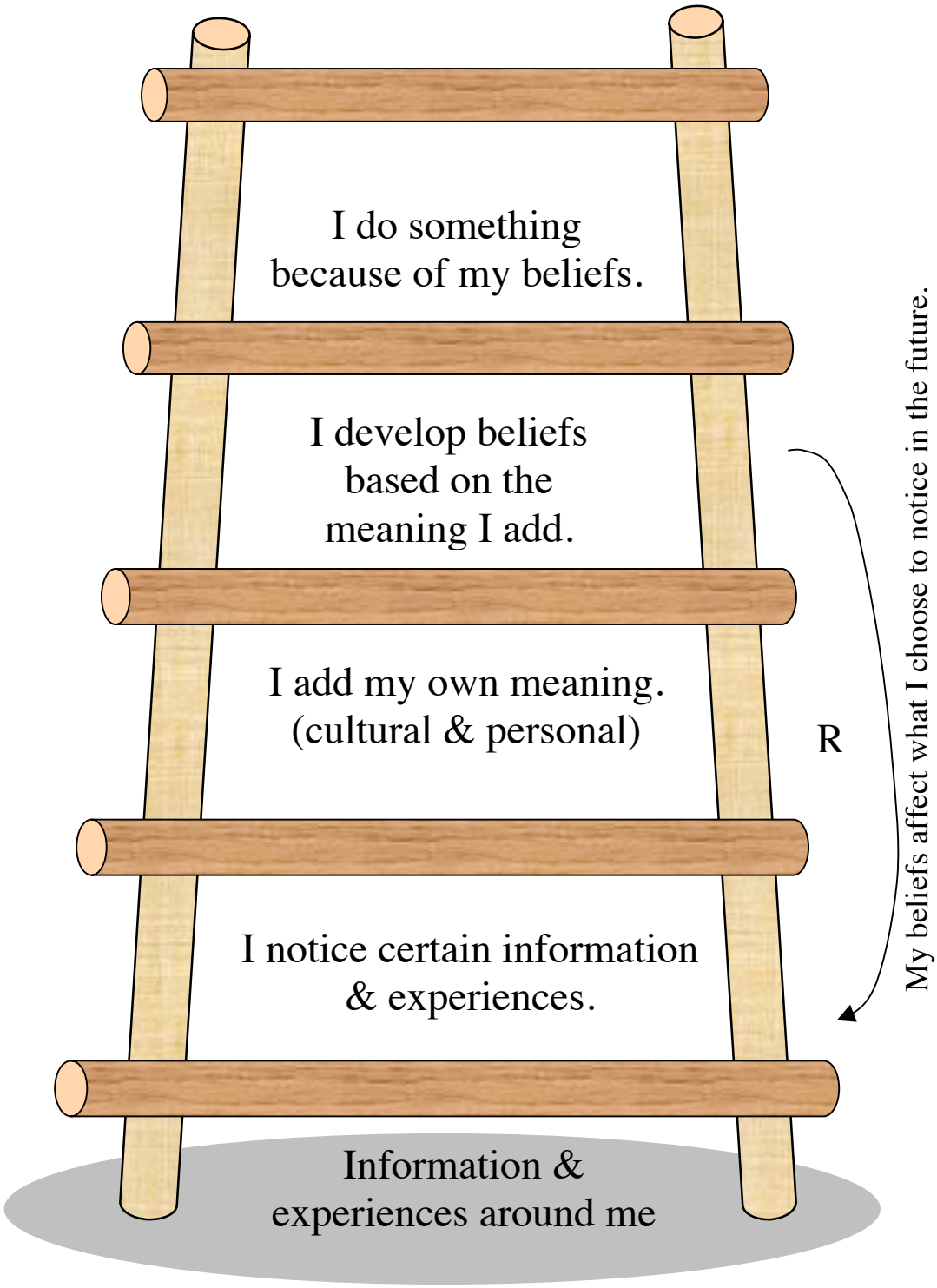


Ladder of Inference



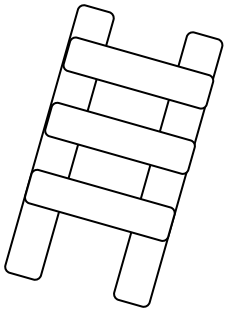
Iceberg Model of Systems Thinking

# Ladder of Inference




*Adapted from The Fifth Discipline Fieldbook*
Systems Thinking in Schools, Waters Foundation

# Practices that help you use The Ladder of Inference



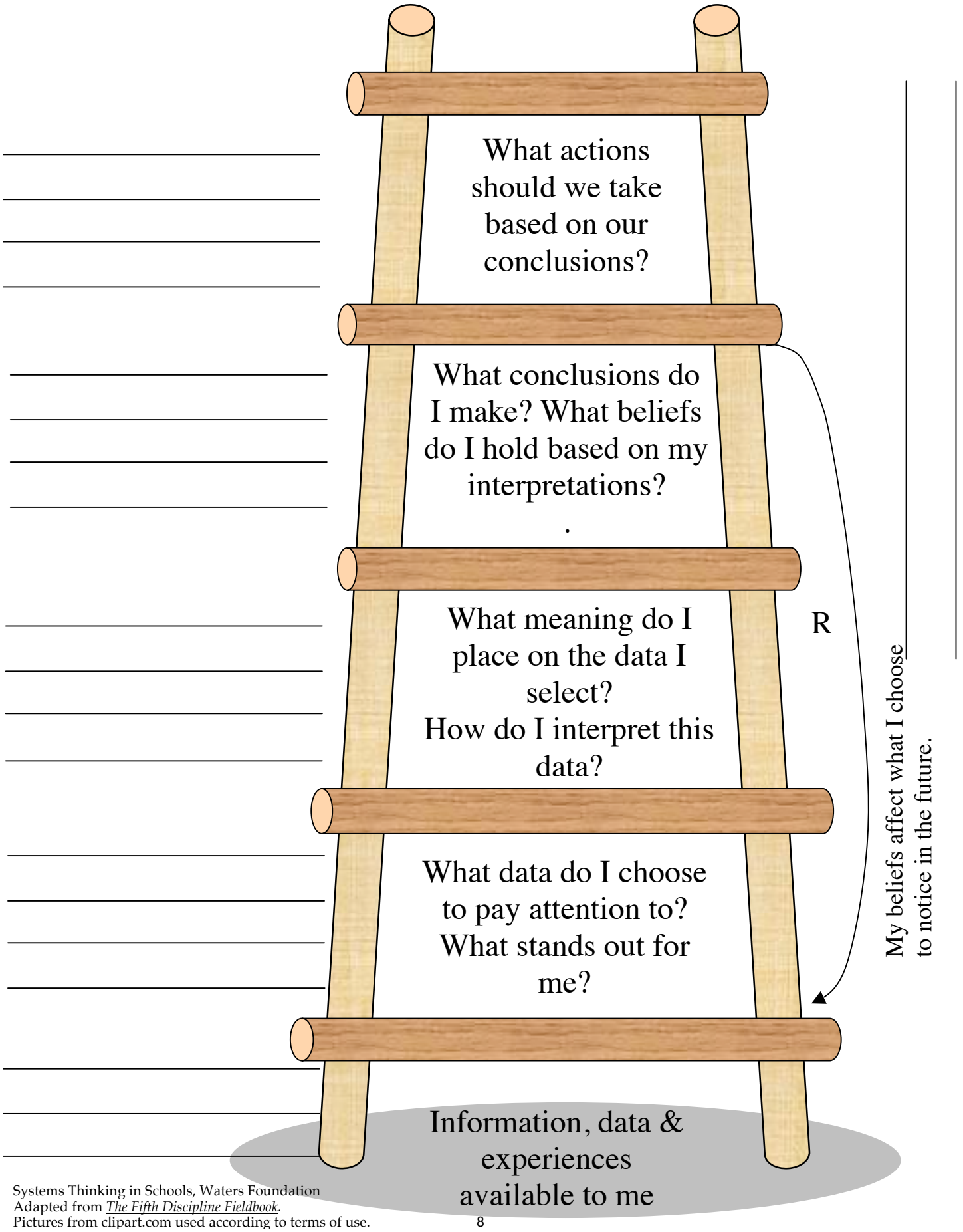
- **Reflection**
  - Suspend judgment
  - Become more aware of your own thinking and broaden your observations

- **Inquiry**
  - Inquire into other's thinking and reasoning
  - Ask open-ended questions that seek clarification

- **Advocacy**
  - Make your thinking and reasoning more visible to others by describing what influenced your thinking and your actions

Notes:

# Applying the Ladder of Inference to the Interpretation of Data



# Iceberg... Seeing What's Below the Surface

Learning

What is seen

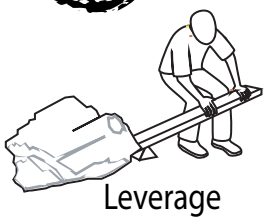
## Events

What happened?

What is generally unseen

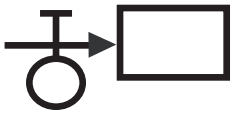
## Patterns of Behavior

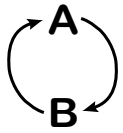
What's been happening?
What are the trends?
What changes have occurred?



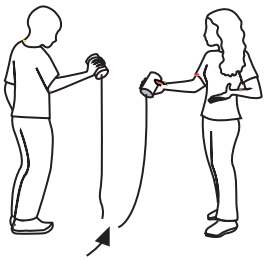
Leverage

## Structure of the System



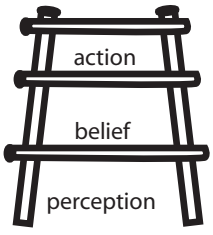


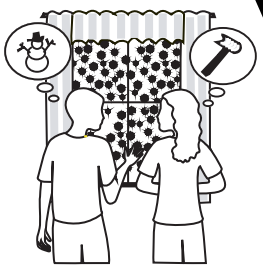

What has influenced the patterns?
(e.g. policies, laws, physical structures)
What are the relationships among the parts?



## Mental Models

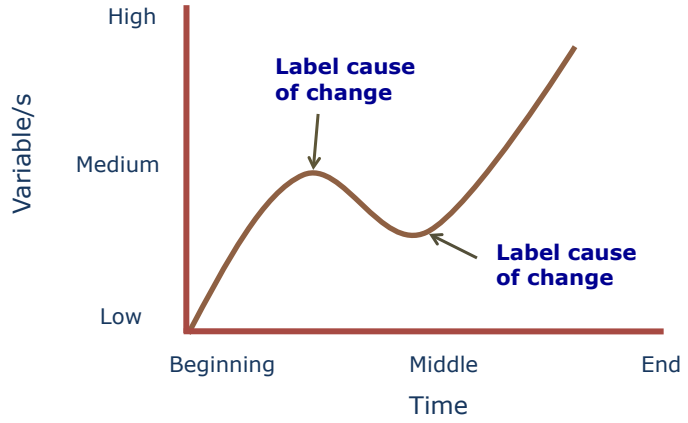
What assumptions, beliefs, and values do people hold about the system?



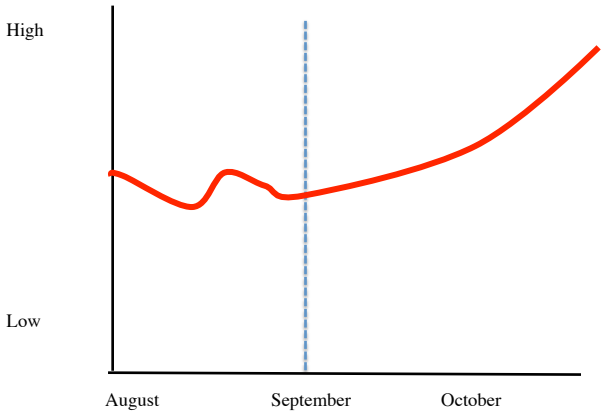



Adapted by Systems Thinking in Schools, Waters Foundation, www.watersfoundation.org, from Innovation Associates, Inc.

# BOTG Basics



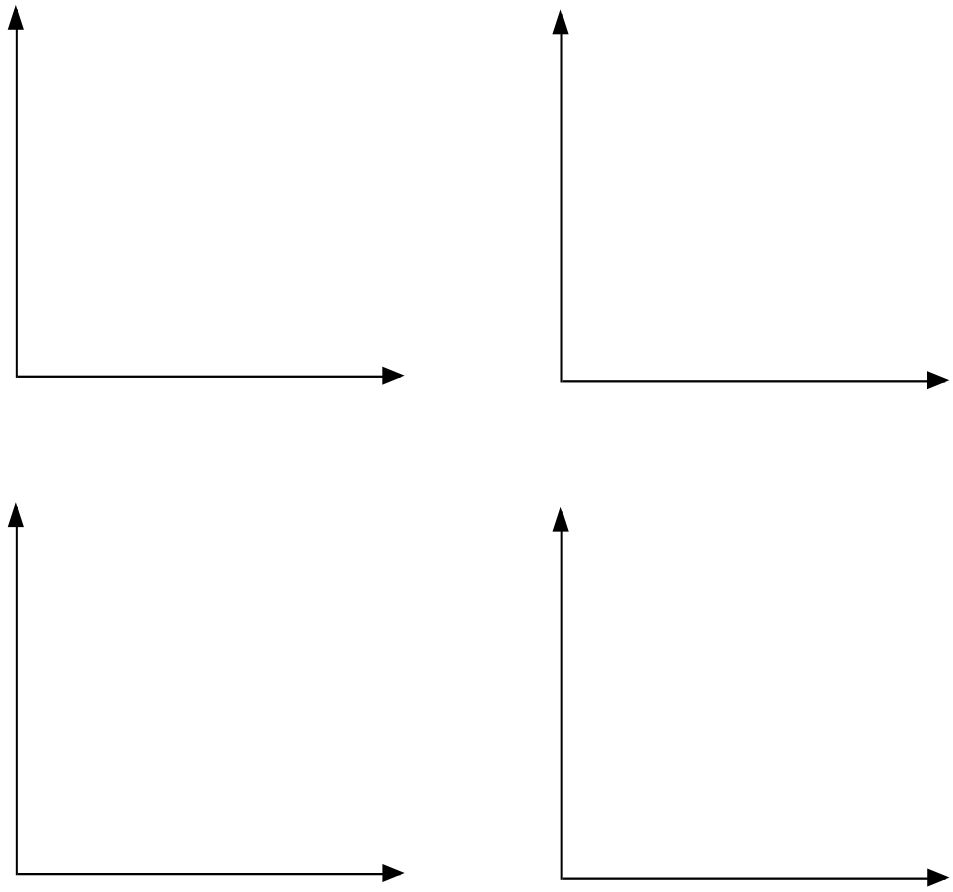

Using BOTGs to identify current and desired trends



## Behavior-Over-Time Graphs:

**What is changing over time?**

**How are the essential elements changing?**



**Some sample questions to ask when identifying parts of a system that change over time:**

- What important elements have changed over time?
- How has _____ changed over time?
- During what period of time have the changes occurred?
- Where on the y-axis should the graph start and why?
- How would you label the bottom/middle/top of the y-axis?
- What evidence supports the graph being created?

**Questions to consider once BOTGs have been created:**

- What caused any changes in direction or slope?
- How are interpretations of a graphed element the same or different?
- What changes may happen in the future based on what has been happening?
- Do you see any connections (interdependencies or causal relationships) between/among graphs?

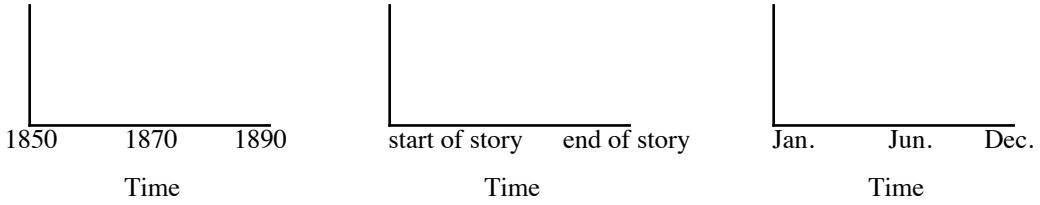
## Tips for Behavior-Over-Time Graphs (BOTGs)

**Behavior-Over-Time Graphs (BOTGs)**: A BOTG is a simple tool that can help people focus on patterns of change over time rather than on isolated events, leading to rich discussions on how and why something is changing. BOTGs focus on trends.

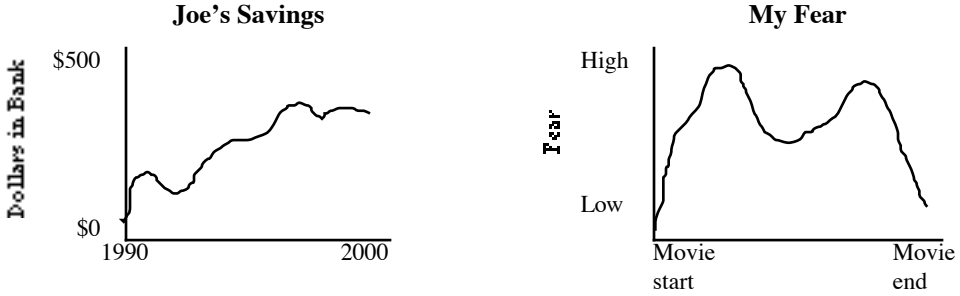
1. A BOTG is a basic line graph showing the trend, or pattern of change, of a variable over time.

2. The X axis:
   - is **always** labeled in units of time or can reflect change in time.
   - has defined beginning and ending points; the precision of the definition can meet your specific purpose.

   Care should be taken to explain the logic for the time scale. Why does it start and end where it does? Examination of when and where a particular pattern of behavior starts, ends, or changes direction is also important.




3. The Y axis:
   - clearly identifies the variable being graphed and **must** be labeled with that variable's name.
   - should not include qualitative words such as more, less, increasing, bigger, etc., in the variable's name; for example, it's difficult to understand "more fear" decreasing over time.
   - may represent "concrete" variables (quantities such as population or temperature) or "abstract" variables (like love or stress).
   - must have a defined scale. Scales can be numeric (e.g., 2 to 1000 rabbits or "on a scale of 0 to 100…") or descriptive (e.g., low vs. high).




4. Different interpretations of the behavior of the variable are definitely possible. Both similarities and differences among graphs are grounds for rich discussion about individual interpretations or mental models.

5. More than one variable can be plotted on the same graph to compare them for possible interdependence or causal relationships between variables. Differentiate between the lines with careful labeling or the inclusion of a key. This step can contribute to thought-provoking discussion.

# How to Make Connection Circles

1. Draw a circle of behavior-over-time graphs (BOTGs). Limit the number to 5 – 10.

2. Elements graphed on the BOTGs should be
    a. relevant to the main idea of the story/text
    b. dynamic, i.e. their values change
    c. nouns or noun phrases, preferably

3. Identify causality: elements that cause other elements to change (increase or decrease).
    a. draw an arrow from the "cause" element to the "effect" element
    b. on the arrow write a verb or action phrase to indicate HOW the cause "acts on" the effect element
    c. label the arrow-head with "S" (indicating a same or direct relationship) or an "O" (indicating an opposite or inverse relationship)

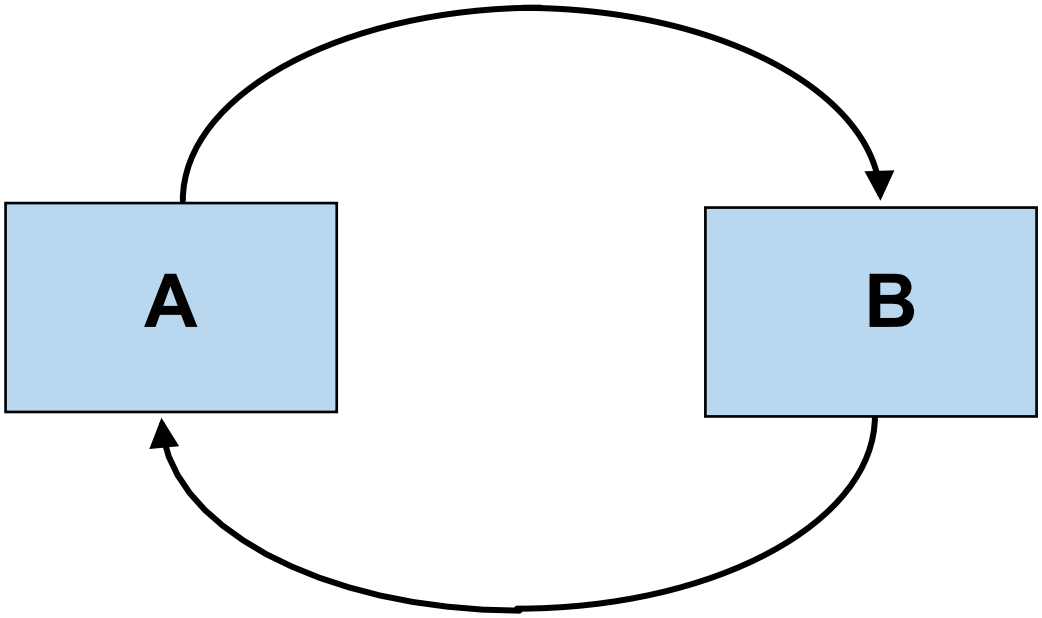
4. Continue this process until you have described all of your causal hypotheses.

5. Identify and analyze *feedback* relationships in the circle. These feedback relationships can be shown in causal loop diagrams (CLDs).

6. Mentally simulate your "model" (tell/retell the story).

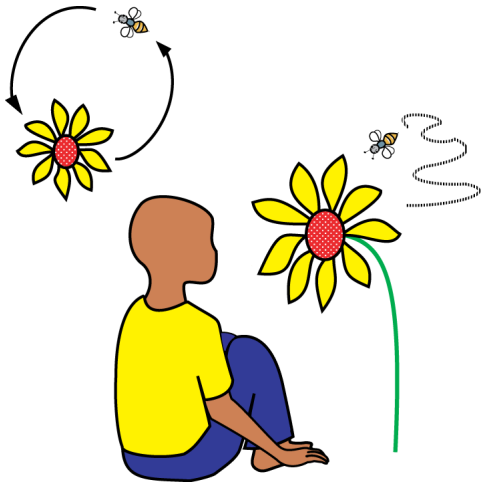
# Causal Loop Diagrams (CLDs)
also known as **Feedback Loops**

**Feedback: As different parts of a system affect each other, causes become effects, which in turn become causes.**



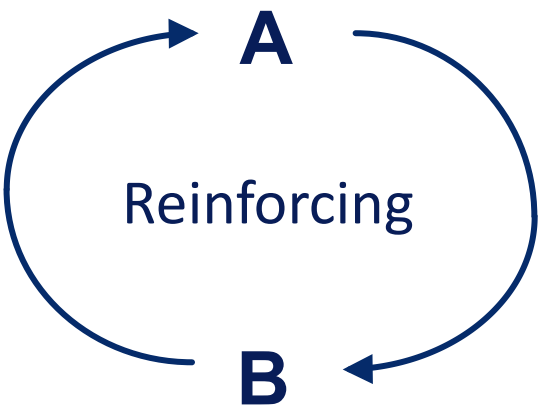

## Habit of a Systems Thinker related to Causal Loops

*A Systems Thinker identifies the circular nature of complex cause and effect relationships.*



# Reinforcing Causal Loops

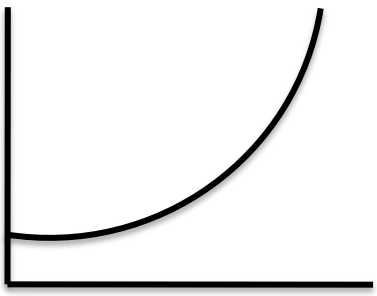
Like a snowball rolling down a hill that gets bigger with each rotation, reinforcing loops represent escalating, compounding growth or decline.

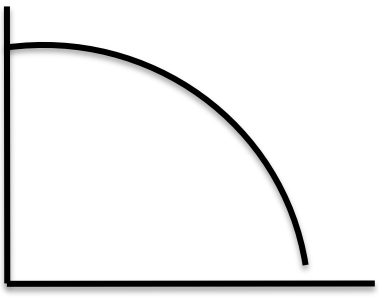



*Language one might hear when reinforcing feedback is present:*

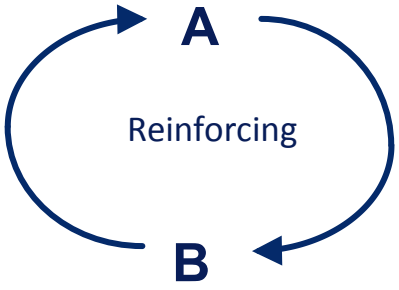
"Things are getting out of control!"
"I can't keep up!"
"We are really on a roll now!"
"The change seems to be doubling."

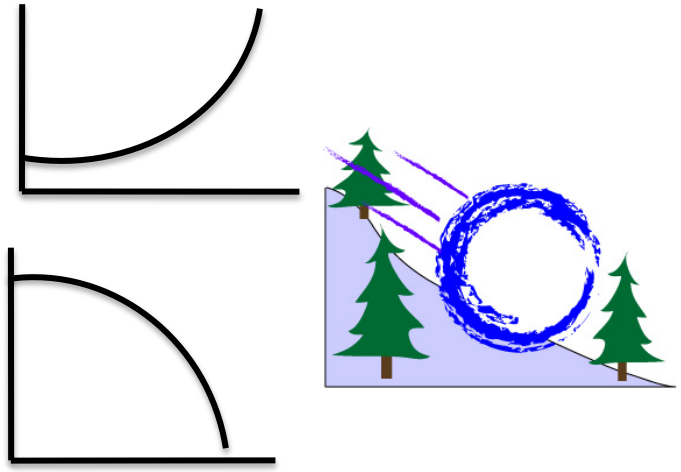
*Examples of behavior-over-time graphs that show reinforcing feedback*





# Reinforcing Causal Loops



**Practice drawing reinforcing loops**

**#1 Choose one pair of variables and draw a reinforcing loop.**

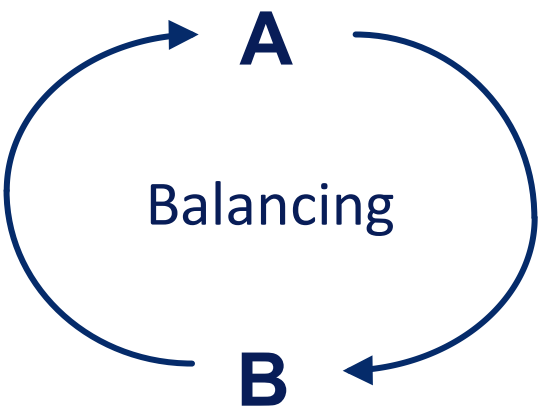
Staff collaboration & Quality of staff communication
Student frustration & Teacher frustration
Peer pressure & Student dependence on peers
Staff commitment & Administrator commitment
Administrator approachability & Quality of communication
Teacher efficacy & Teacher belief in student capabilities
School reputation & Enrollment

**#2 Choose one of the elements below and ask yourself *"What other changing element(s) would cause this element to grow or decline in a reinforcing direction?"* Design and draw your loop. When finished, share with others at your table.**

Teacher Buy-in to ECERS
Principal Buy-in to ECERS
Parent Involvement
Professional Learning
Teacher Self-reflection
Professional Capital
Organizational Alignment
Culture of Collaboration
Social-Emotional Learning
Other?

# Balancing Causal Loops

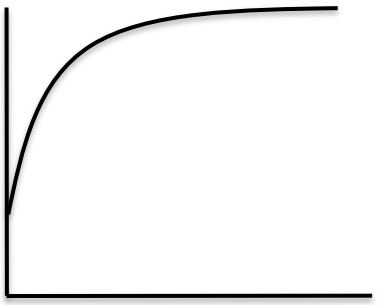
Balancing situations strive to achieve system goals or reach equilibrium.

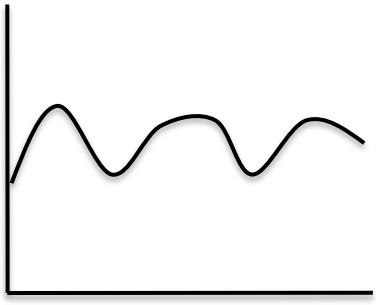


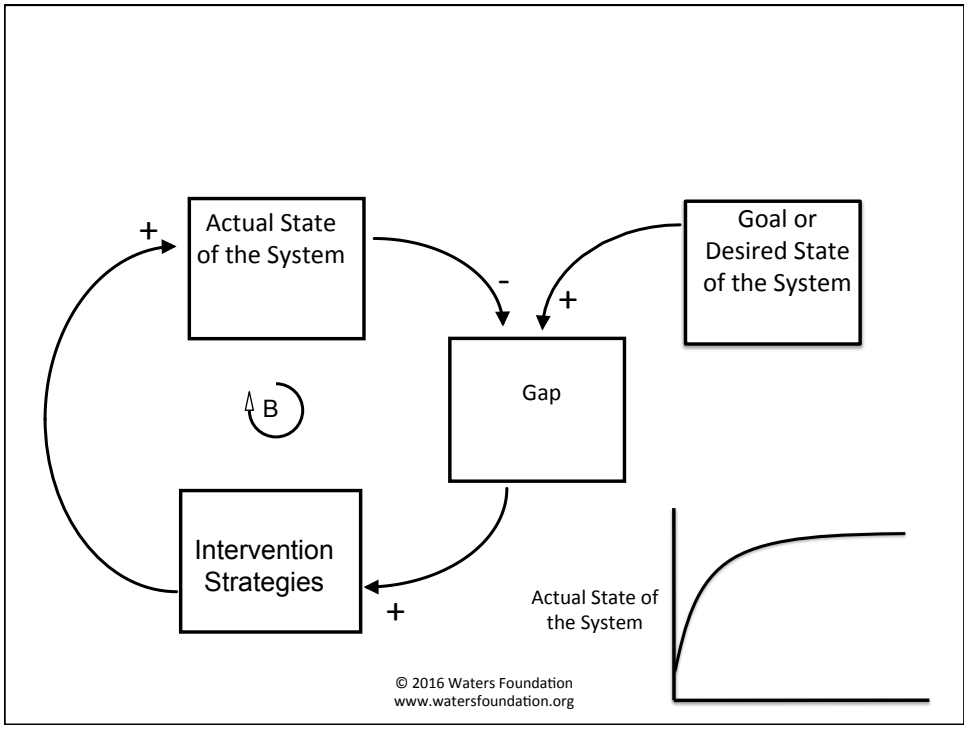

*Language one might hear when balancing feedback is present:*

"We are experiencing some subtle ups and downs."
"I can sense that things are beginning to settle down."
"We seem to be achieving balance and stability."
"The system is reaching our goal and closing the gap."

*Examples of behavior-over-time graphs that show balancing feedback*






+
Actual State of the System
-
+
Goal or Desired State of the System
B
Gap
Intervention Strategies
+
Actual State of the System
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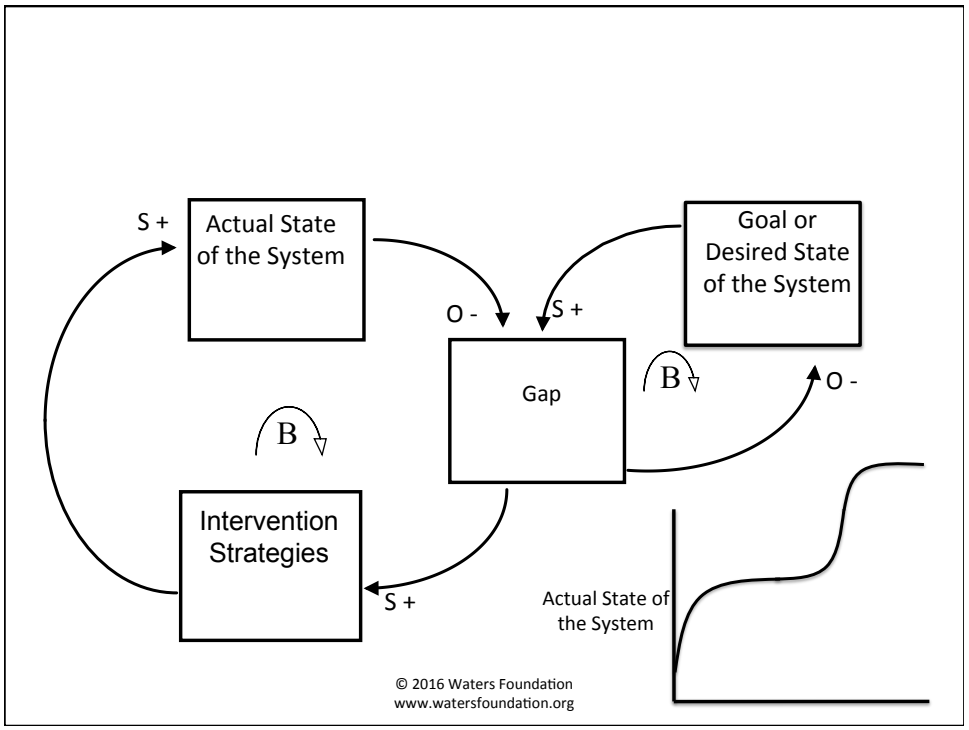
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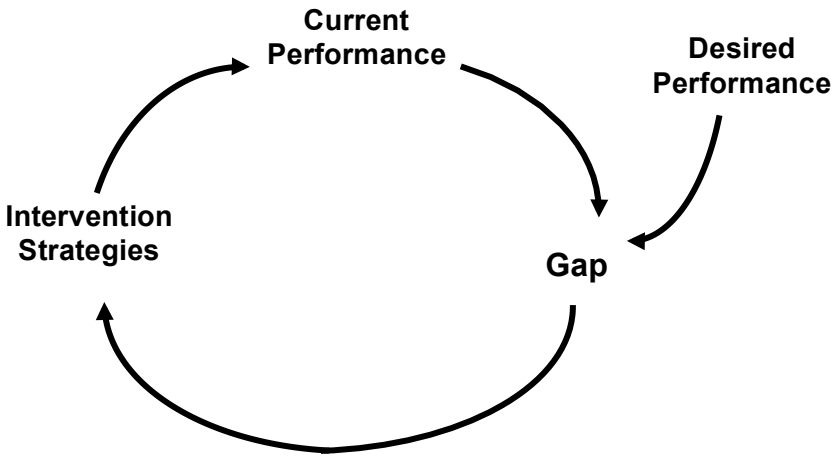
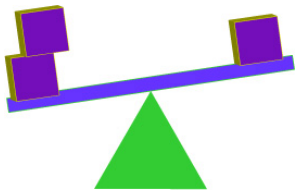
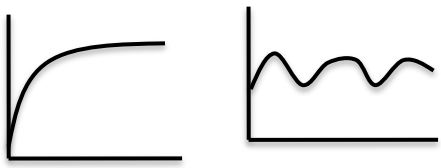
# Balancing Causal Loops





**Practice drawing balancing loops**

**#1. Choose one pair of variables and draw a goal-gap balancing loop.**

- Items in your inbox & Time available to respond
- Student aggression during a fight & Intervention
- Nasty rumor & Need to communicate accurate information
- Stress & Coping strategies (e.g. exercise, breathing, rest)
- Disruptive behavior & Classroom management strategies
- ECERS score & professional development

**#2. Choose one of the elements below and ask yourself *"Assuming there is a gap related to each element below, what intervention would help address the gap?"* Design and draw your loop. When finished, share with others at your table.**

- Parent Involvement
- Culture of Collaboration
- Developmentally Appropriate practice
- % of Children screened
- Free Choice Play
- Teacher Efficacy
- Other

# Tips for Causal Loop Diagrams (CLDs)

**Causal Loop Diagrams (CLDs)** help one understand and communicate the interactions that determine the dynamics of a system. System behaviors are generated from within the system and are the result of one or more causal (or feedback) loops. CLDs illustrate how "structure generates behavior" within a system.

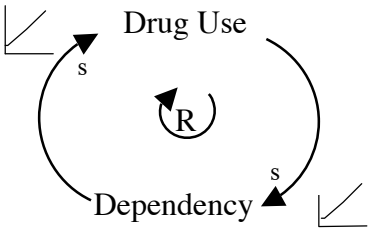
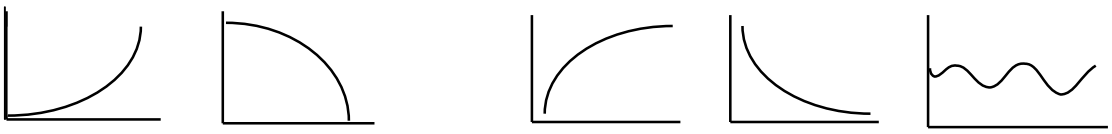


Figure 1

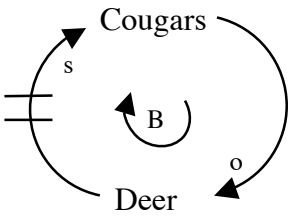
1. CLDs show causal relationships and illustrate circular feedback within a system. *A cause becomes an effect, becomes a cause*. You should be able to read around the loop several times. *"What goes around comes around."*
2. You may choose to identify important CLDs by looking for causal relationships among behavior-over-time graphs (BOTGs) that describe the system or by extracting those found within Stock/Flow maps and computer simulations.

   *Since CLDs are about the causes of change, it is helpful to identify how key elements actually did change by drawing accompanying BOTGs (See Fig. 1: As drug use goes up, dependency goes up; as dependency goes up, drug use goes up.)*
3. Find a specific focus for the loop(s) you draw, taking into account the purpose and audience for the loop(s). A CLD can help you tell a story or express your interpretation or mental model of how a system works. A single, understandable CLD can describe a simple system or a part of a more complex one.
   *Pick one aspect of the system. Focus on a behavior that is changing over time. What are the causes? What are the effects? This/these become the other aspects of the loop(s).*
4. CLDs contain 4 elements (See Fig. 1):
   a. variables that are related in cause/effect sequence(s) (See #5 below.)
   b. arrows that indicate which elements are affecting other elements
   c. symbols associated with the arrows that denote the direction of the influence of the relationships (See #6 below.)
   d. a central symbol indicating the overall identity of the loop (either "R" reinforcing or "B" balancing) (See #7 below.)
5. All variables in a CLD must be able to increase or decrease; at least one must be a stock, i.e. an accumulation. (See "Tips for Stock/Flow Maps.")
   a. Choose precise, non-repetitive terms for the variables in CLDs, e.g., "Feelings" is too nebulous a term to include in a loop. Try a more specific feeling such as "happiness," "sadness," or "frustration" instead.
   b. Do not use words such as more/less, or increases/decreases in the variable name. It is very hard to interpret less "more drug use" or more "less drug use."
6. Symbols associated with the arrowhead end of each arrow indicate the effect of the influence.
   a. An "S" means that both variables move in the same direction. If the first variable increases, the second variable will be greater than it would have been otherwise; a decrease in the first causes the second to be less than it would have otherwise been. A "+" may be used in a similar although not identical fashion.*
   b. An "O" shows that the two variables change in the opposite direction. If the first variable increases, the second will be less than it would have been otherwise; a decrease in the first variable causes the second to be greater than it would have been otherwise. A "-" may be used in a similar, although not identical, fashion. *For clarification of the difference between "S" and "+" and "O" and "-," refer to writings by John Sterman and/or George Richardson.
7. A CLD may be "reinforcing" and grow, or shrink, until acted upon by a limiting force, or "balancing" and move toward, return to, or oscillate around a particular condition. Reinforcing loops are marked with an "R" in the center; balancing loops are indicated with a "B" in the center . *Graphs of behaviors from:*

*Reinforcing Loops* *Balancing Loops*



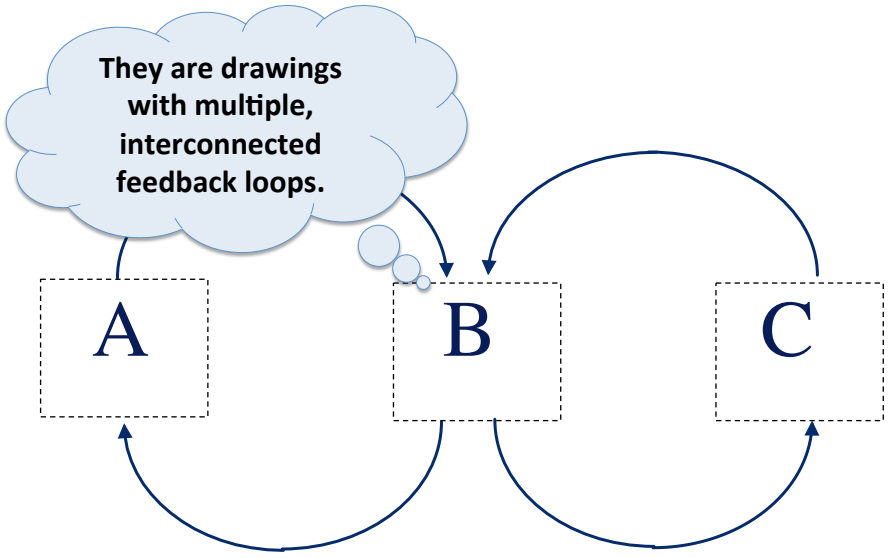
8. If there is a significant amount of time between the action of one variable and the reaction of the next variable in the loop, a time delay can be indicated by drawing two short, parallel line segments across the arrow that connects those two variables.



# Causal Loop Archetypes

Archetypes capture **"common stories"** that occur repeatedly in diverse settings.

# What do they look like?



## Causal Loop Archetypes help you see and understand systems.

Archetypes are **lenses** or **perspectives** from which to see causal connections that create system behavior.

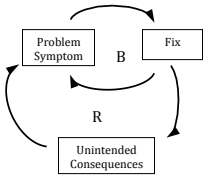
And, they help you anticipate possible problems before they occur.

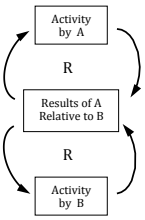
Archetypes help you visually describe a complex situation or system.

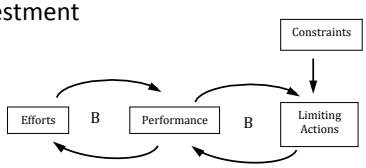
Archetypes are **shorthand** for diagramming complex cause-effect relationships.

## There are many archetype stories.

- **Fixes that Backfire**
- **Shifting the Burden**
- Drifting Goals
- Success to the Successful
- Escalation
- Accidental Adversaries
- Tragedy of the Commons
- Growth and Underinvestment
- Limits to Success
- Revolution
- Story Structure



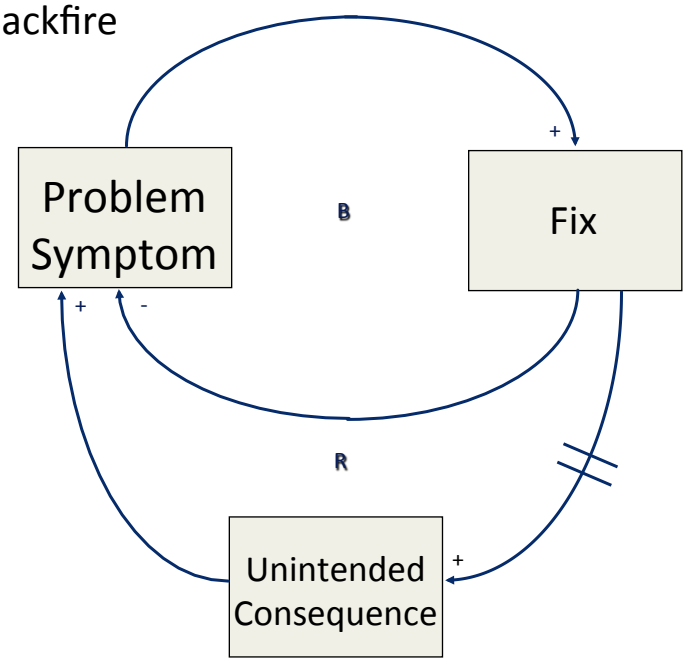



# Fixes that Backfire Questions

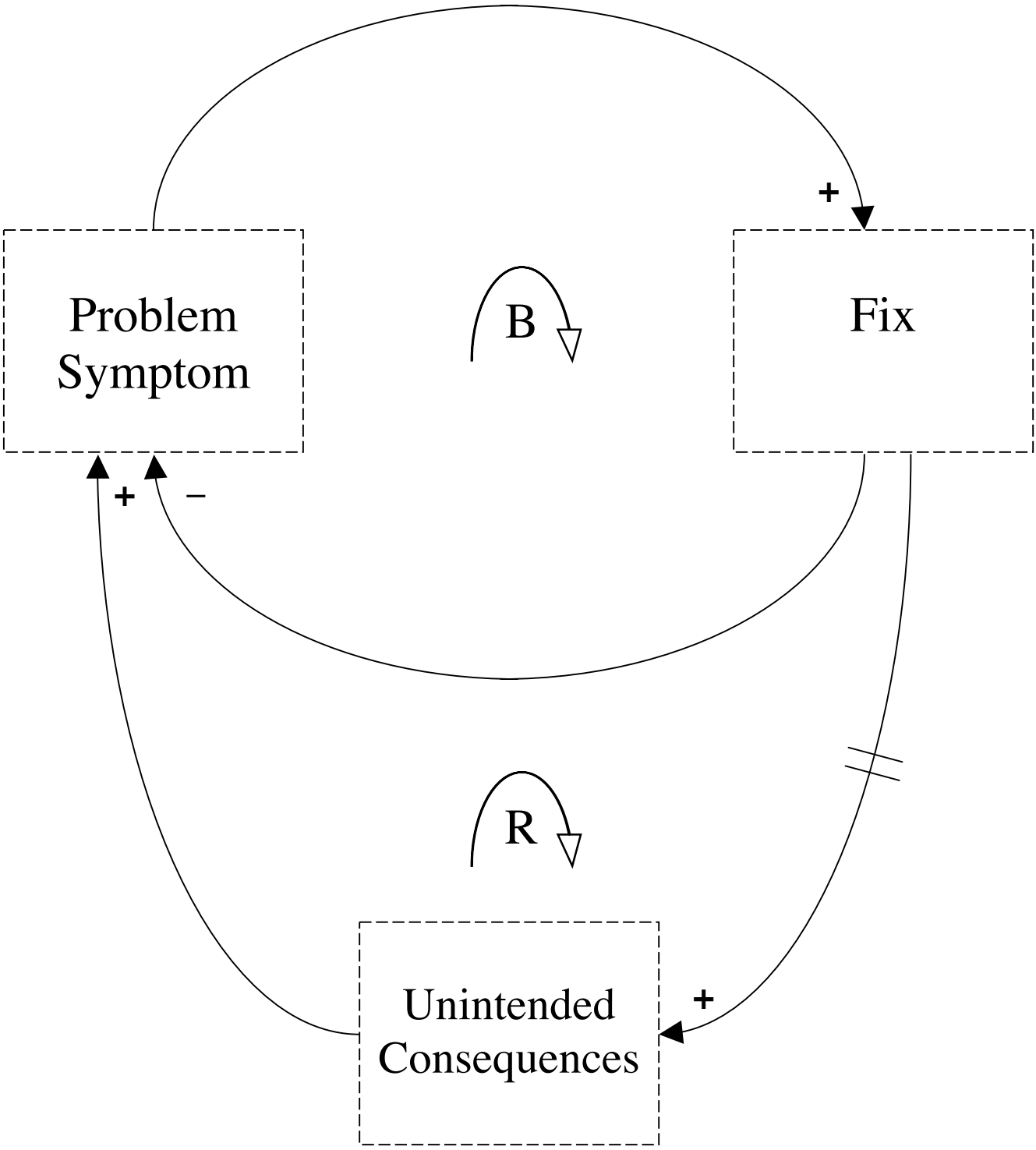
Has the need to respond quickly to a problem been greater than the importance of investigating potential unintended consequences?

Did the response help to reduce the problem in the beginning, but overtime, did consequences actually contribute to the original problem?

## Fixes that Backfire

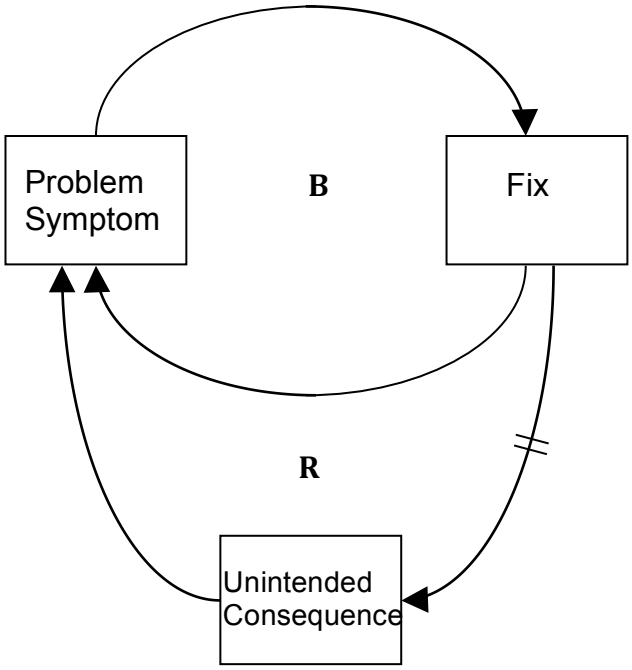


# Fixes-that-Backfire




Handout by Systems Thinking in Schools, Waters Foundation, www.watersfoundation.org, based on archetype described in *The Fifth Discipline,* Senge and by Innovation Associates, Inc.

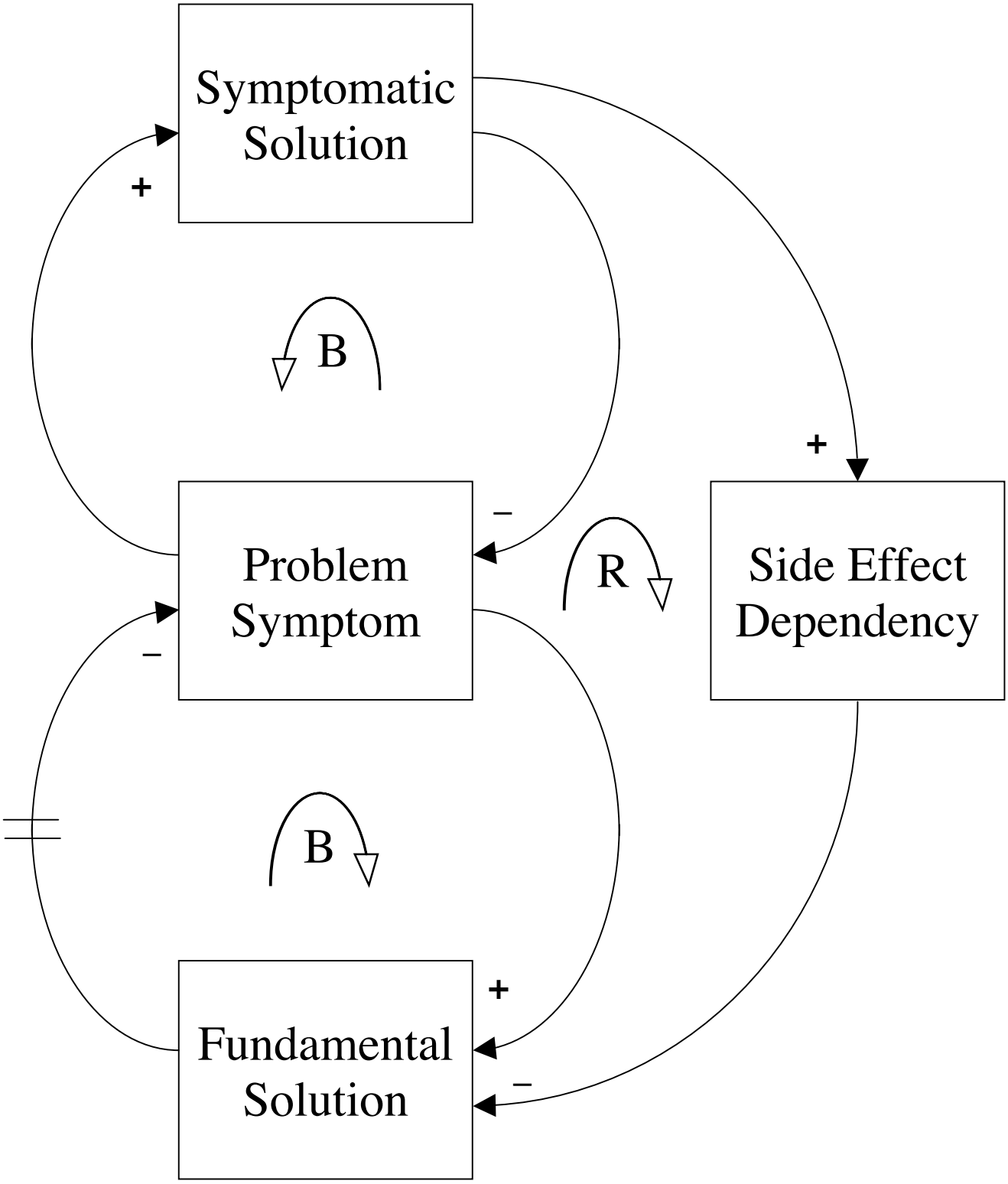
## 16ystems Archetype: Fixes that Backfire




…when you think you've solved a problem in the short run, yet the solution actually makes the problem worse in the long run.

| **Description:** | **Ways out:** |
|---|---|
| In a Fixes that Backfire scenario, a problem symptom requires a fix, oftentimes a "quick fix." The fix then alleviates the problem, resulting in a balancing dynamic that addresses the problem in the short-term. However, unintended consequences emerge as a result of the fix that come back and actually cause the original problem symptoms to reoccur and even become worse. | Breaking this cycle usually requires an acknowledgement that the fix was shortsighted. Efforts to generate a solution that minimizes the effects of the unintended consequences are needed.<br>**As a tool for prevention:**<br>The fixes that backfire archetype is a valuable tool to use before a fix is implemented. Ask people to consider the possible unintended consequences of a proposed fix. Both short-and long-term consequences and unintended consequences should figure into the discussion. An informed decision that considers all of the trade-offs of applying the fix will minimize the potential for backfire. |
| **Questions to ask** | |
| Has the need to respond quickly to a problem been greater than the importance of investigating potential unintended consequences? | Did the response help to reduce the problem in the beginning, but overtime, did consequences actually contribute to the original problem? |

# Shifting the Burden

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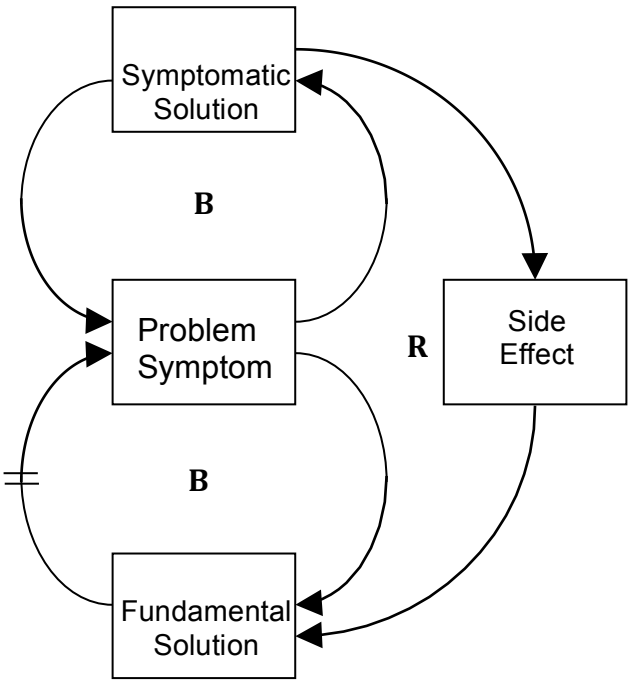
## Systems Archetype: Shifting the Burden




…when you choose a short-term solution and its side effect undermines your ability to implement a long-term, more fundamental solution.

**Description:**
In a Shifting the Burden scenario, a problem symptom is solved with a symptomatic "quick fix." The fix then alleviates the problem, resulting in a balancing dynamic that addresses the problem in the short-term. However, a side effect emerges that diverts attention away from more fundamental solutions. Side effects are often related to addictions or dependencies. The system can become more and more dependent on the symptomatic solution and less and less able to achieve a desired state.

**Ways out:**
Breaking this cycle usually requires an acknowledgement that the fix was shortsighted. Efforts should focus on the fundamental solutions and minimize the effects of side effects. Beware of symptom–relieving practices that don't really address the problem or delay attention to sustainable solutions.

**As a tool for prevention:**
The shifting the burden archetype is a valuable tool to use when deciding on solutions to problems. Whether a solution is symptomatic or fundamental often depends on one's perspective. Explore possible solutions from various perspectives. An informed decision that considers the potential for addictive or dependent side effects is preferable.

**Questions to ask**

| | |
|---|---|
| Are actions taken to address the problem making it difficult to implement more fundamental, sustainable solutions? | What side effects result from solutions that may increase dependency and erode the capacity to implement a fundamental solution? |

# Adapted Tuning Protocol

Choose who will be the first presenter (each fellow will take a turn being the presenter and when not presenting, will serve as a peer coach).

| | |
|---|---|
| 5 minutes | One fellow shares his/her Iceberg by describing each level of analysis: events, patterns and trends, structure and mental models. The levels can be described in any order, and the presentation will include the learning and leverage actions. |
| 3 minutes | The peer coach(es) pose questions of clarification with the presenting fellow responding to those questions. |
| 3 minutes | The peer coach(es) provide feedback<br>"I really like…"<br>"I wonder if…"<br>"Have you considered…"<br>Other |
| 4 minutes | General discussion as to how the clarifying questions and feedback will help increase learning and identify leverage actions related to the job-embedded project |
| Switch Roles and Repeat Process | |

Notes:

# Habits of a Systems Thinker