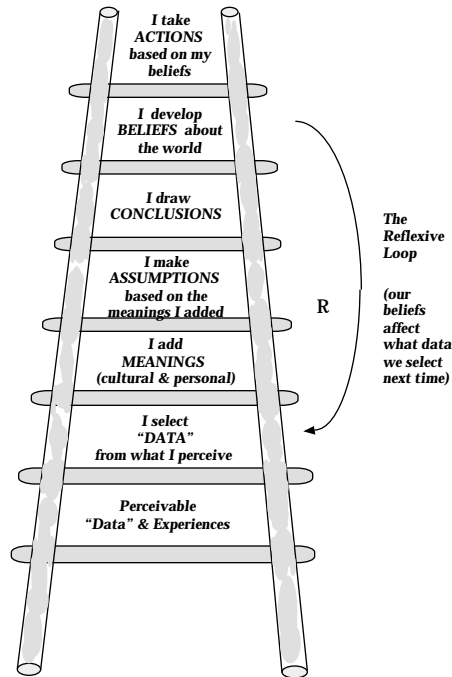


**Having to know
the answers puts us
in terrible positions
from which to learn.**

D. Kim

Ladder of Inference



Adapted from The Fifth Discipline Fieldbook Last modified - 1/1999

Two Modes of Group Communication

Skillful Discussion	Dialog
<p>Intending to:</p> <ul style="list-style-type: none"> • make a decision • reach an agreement • identify priorities <p>Involves convergent thinking</p>	<p>Intending to:</p> <ul style="list-style-type: none"> • explore • discover • gain insight <p>Does not necessarily involve convergent thinking</p>

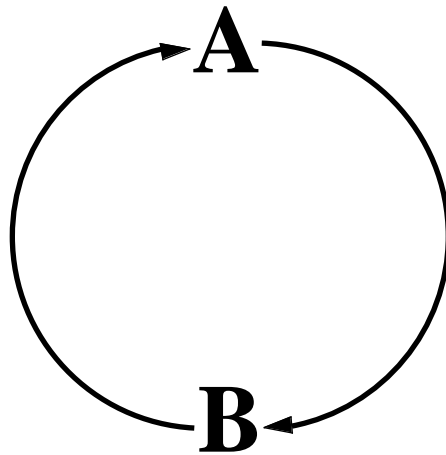
Adapted from The Fifth Discipline Fieldbook , Senge et al, 1994
Last modified - January 9, 1998

What is System Dynamics?

Two parts:

- system: interdependencies, causality, feedback

Feedback in a System



What is System Dynamics?

Two parts:

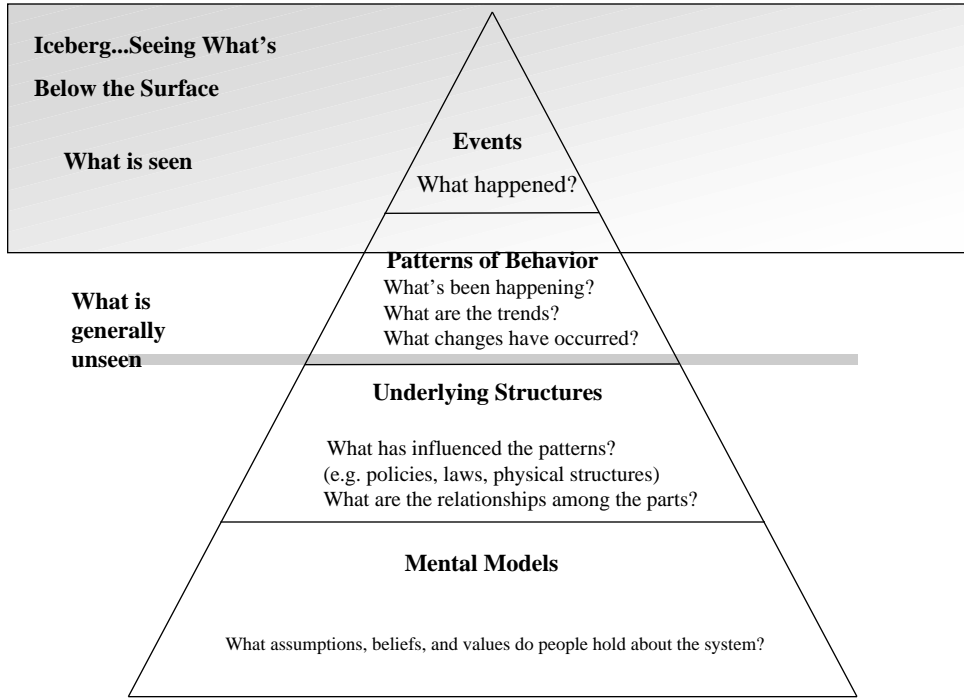
- system: interdependencies, causality, feedback
- dynamics: how elements of the system change over time

To Think and Act Systemically

- **identify that a system of interdependent parts exists within specified boundaries**
- **analyze and understand the interdependencies among parts of a system, particularly feedback relationships (how something that was initially an “effect” ultimately becomes a “cause”)**
- **analyze and understand the conditions that create/affect the interdependencies**
- **analyze and understand the cumulative effects over space and time that are caused by the interdependencies**

Relative to a goal:

- **determine and understand the choices available within a system and the inherent trade-offs that result from those choices**
- **identify short and long-term effects of the trade-offs within a system**
- **make decisions and take action based on an understanding of the trade-offs and the accumulations over time within a system**



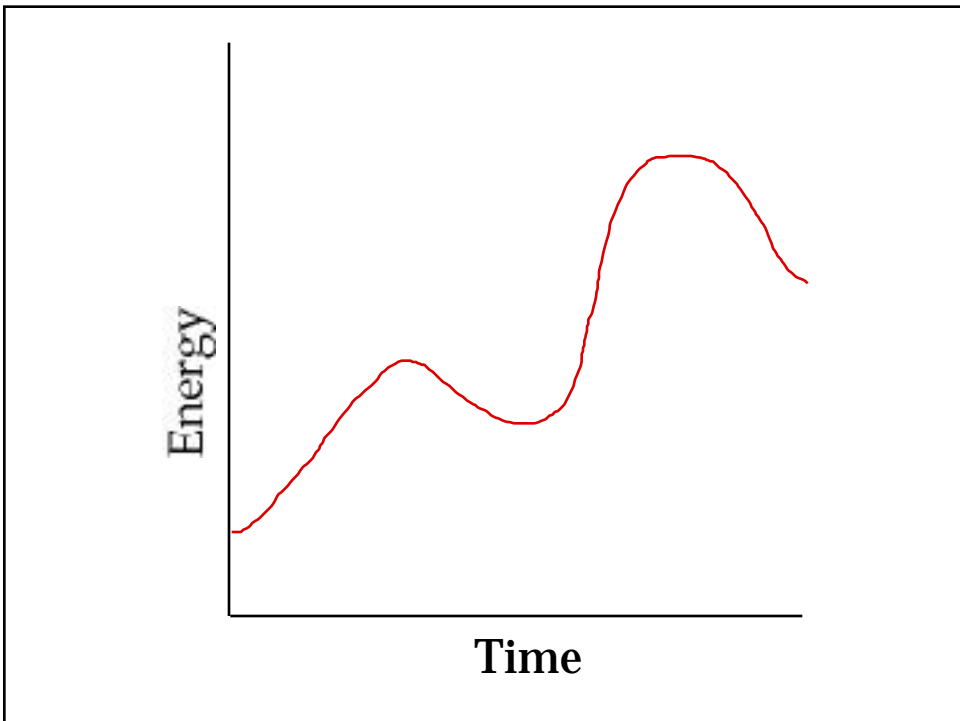
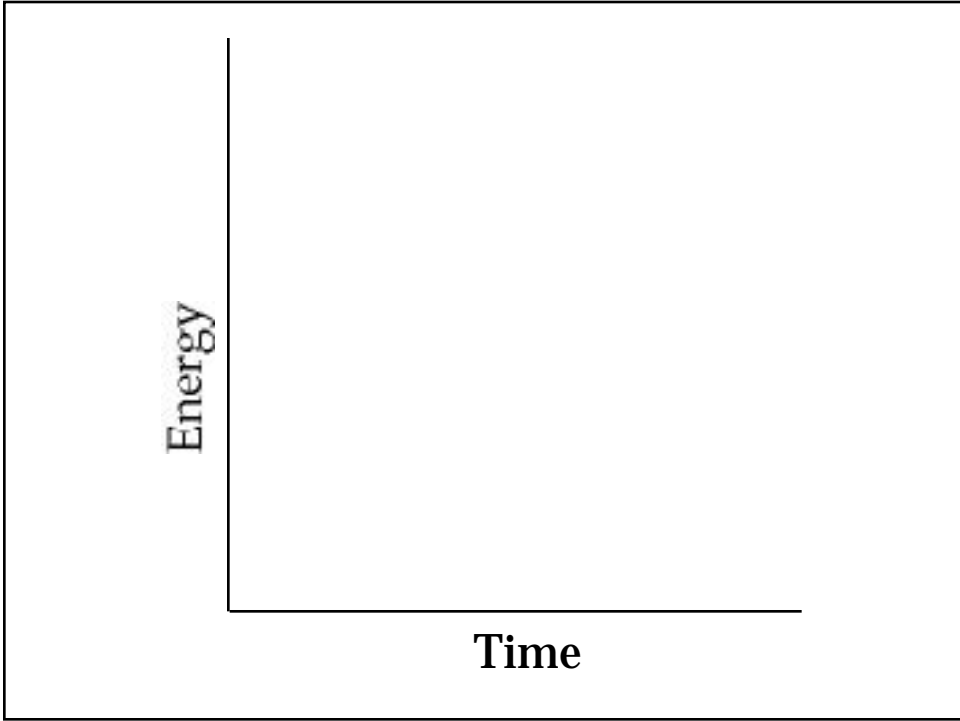
Adapted by Waters Foundation, CFSD from Innovation Associates, Inc.
2/99

CONCEPTS	TOOLS
<u>Change over time</u> <ul style="list-style-type: none"> • patterns and trends • accumulations 	<ul style="list-style-type: none"> • Behavior-over-time graphs (BOTGs) • Stock/flow diagrams • Ladder of Inference • Models - 3-D, mental, computer • Other simulations
<u>Feedback</u> <ul style="list-style-type: none"> • interdependencies • reinforcing and balancing relationships 	<ul style="list-style-type: none"> • Causal Loop Diagrams (CLDs) • Systems Archetypes • Stock/flow diagrams • Models -3D, mental, computer • Other simulations
<u>Leverage</u> <ul style="list-style-type: none"> • structure generates behavior • short & long term consequences • trade-offs • temporal and spatial boundaries 	<ul style="list-style-type: none"> • Iceberg • Ladder of Inference • Stock/flow diagrams • BOTGs • Models- 3D, mental, computer • Other simulations

Behavior-over-time Graphs (BOTGs)

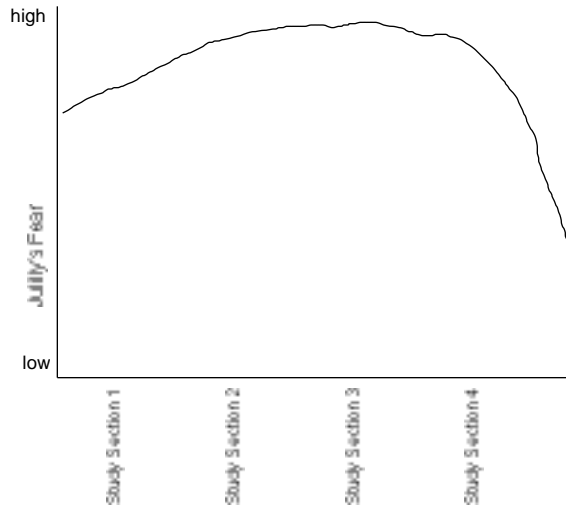
BOTGs show trends and patterns of behavior in a system, rather than discrete events. They measure change over time and show “what” has happened in the system relative to the graphed component. They help us:

- analyze and understand the cumulative effects over space and time that are caused by the interdependencies
- identify short and long-term effects of the trade-offs within a system



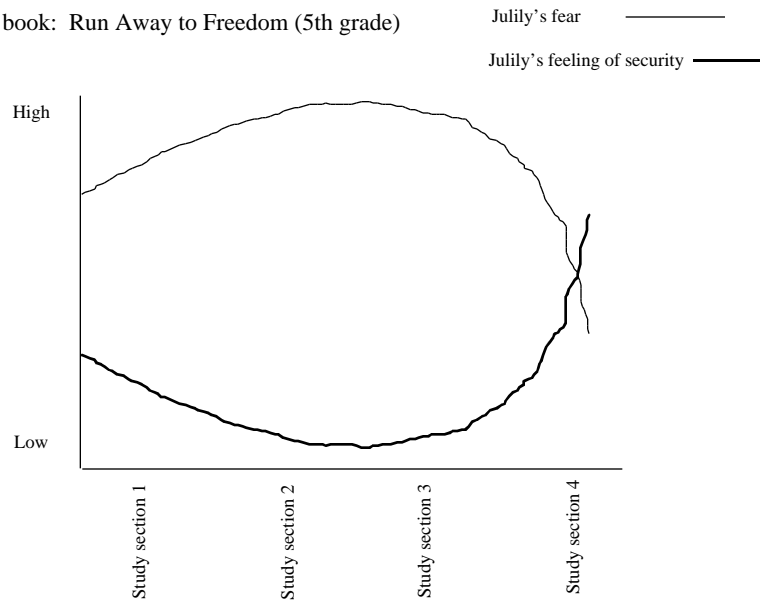
BOTG - Elementary School Literature

BOTG from the book: Run Away to Freedom (5th grade)

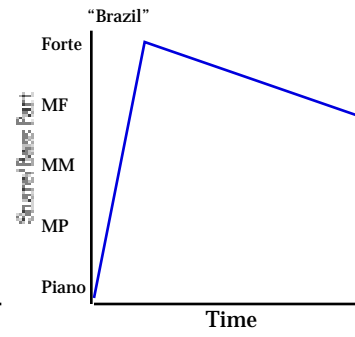
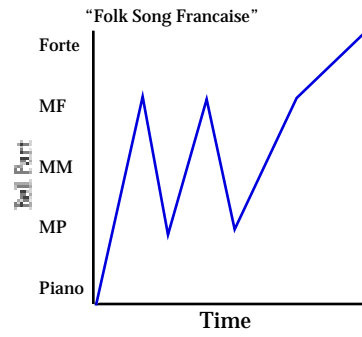
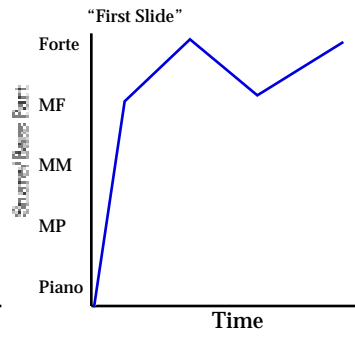
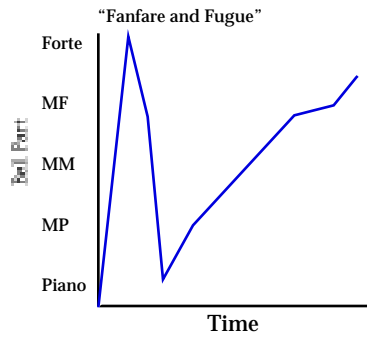


BOTG - Elementary School Literature

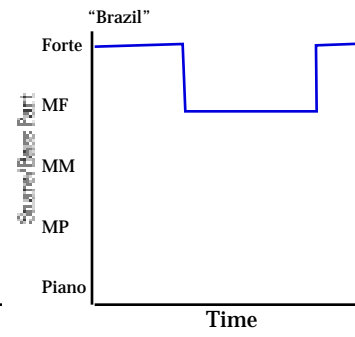
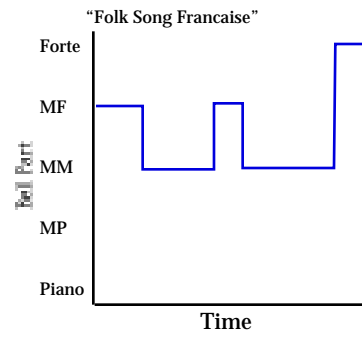
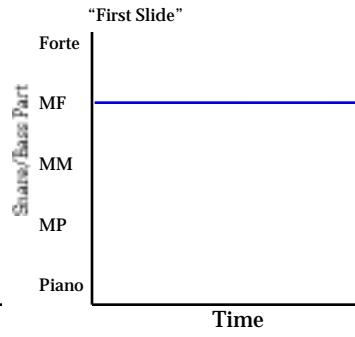
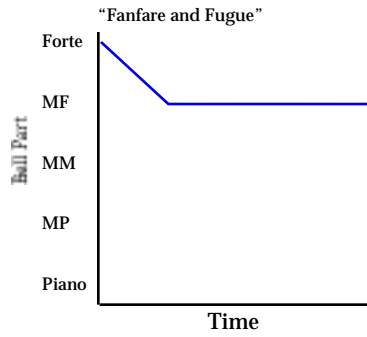
BOTG from the book: Run Away to Freedom (5th grade)



BOTG - Middle School Band

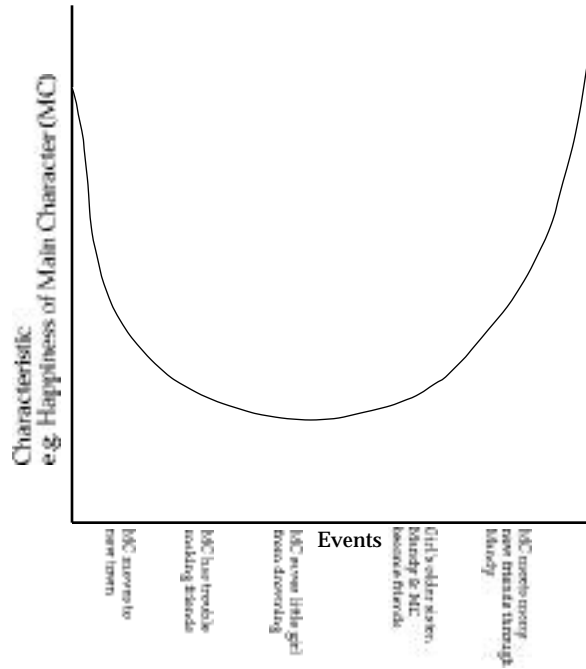


BOTG - Middle School Band - Page 2

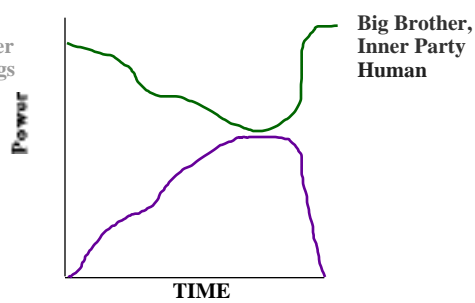
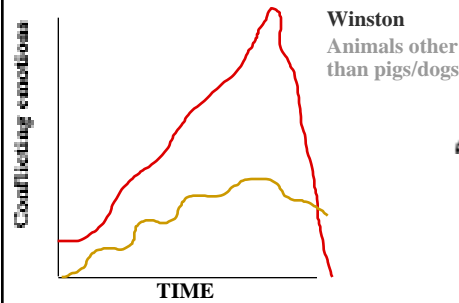
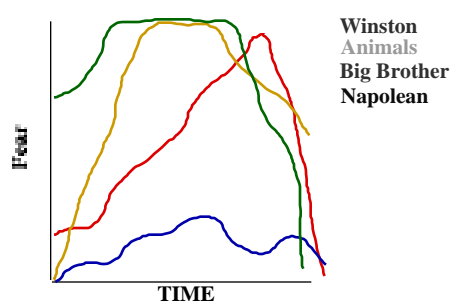
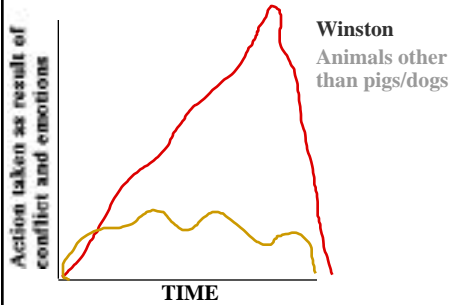


BOTG - Middle School Writing

As a pre-writing activity, students graphed a characteristic of the main character that they wanted to change throughout the story. They planned the events that they would write into the story that would influence the characteristic as graphed.

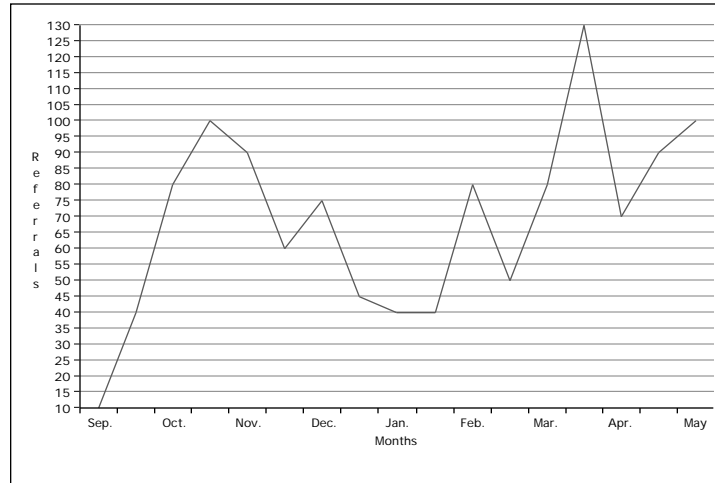


Behavior-over-time Graphs Comparing Animal Farm and 1984



BOTG - STITO Example

Staff looked at the number of student discipline referrals at their school. They wanted to consider what structures currently in place contributed to the increase and decrease and how they might find leverage to change certain trends. NOTE: This is not the graph they created, but is a fictitious example.



Causal Loop Diagrams (CLDs)

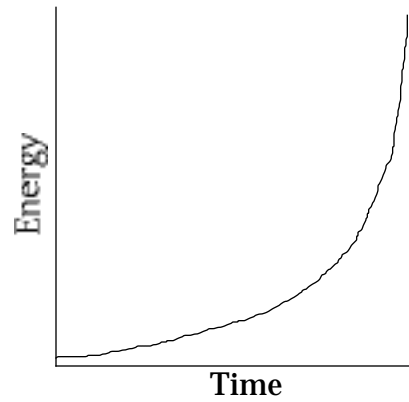
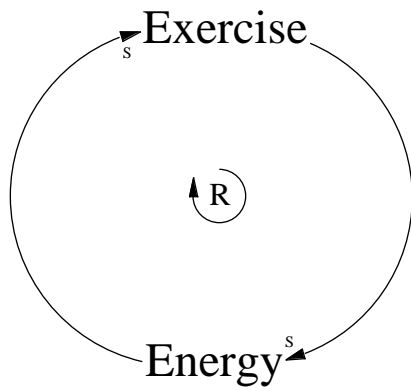
CLDs show causal relationships and circular feedback within a system. They help us:

- **identify that a system of interdependent parts exists within specified boundaries**
- **analyze and understand the interdependencies among parts of a system, particularly feedback relationships (how something that was initially an “effect” ultimately becomes a “cause”)**
- **analyze and understand the conditions that create/affect the interdependencies**
- **analyze and understand the cumulative effects over space and time that are caused by the interdependencies**

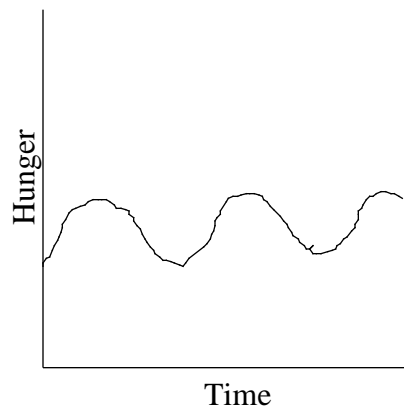
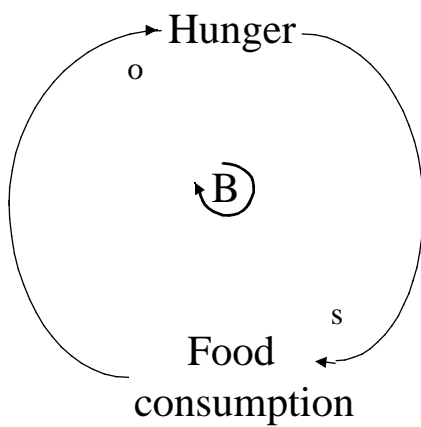
Relative to a goal:

- **determine and understand the choices available within a system and the inherent trade-offs that result from those choices**
- **identify short and long-term effects of the trade-offs within a system**

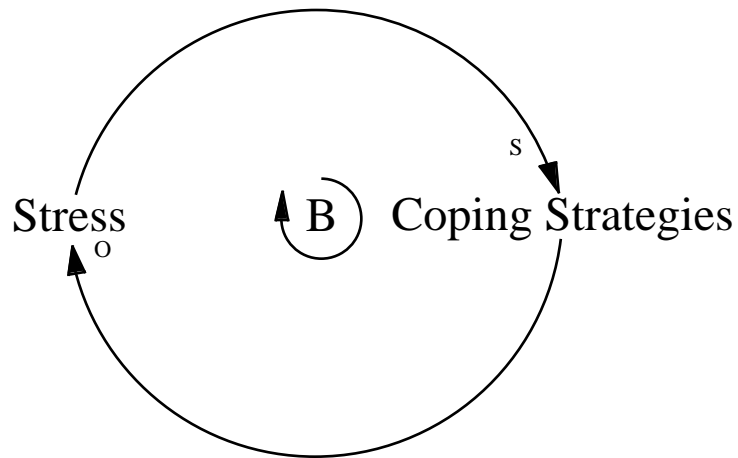
Reinforcing Causal Loop Diagram



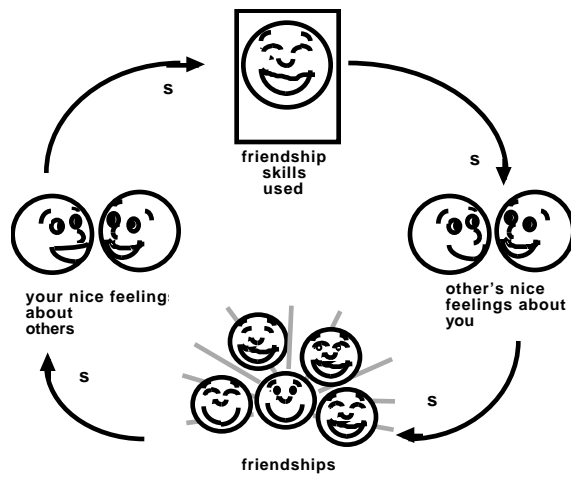
Balancing Causal Loop Diagram



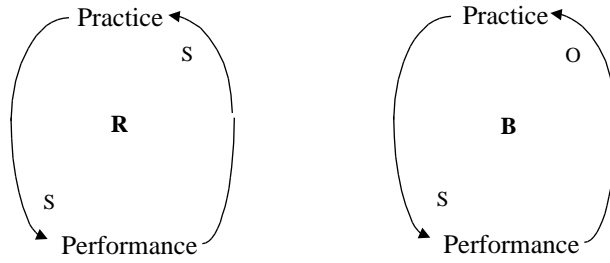
CLD - General Example



"friendship skills" causal loop diagram

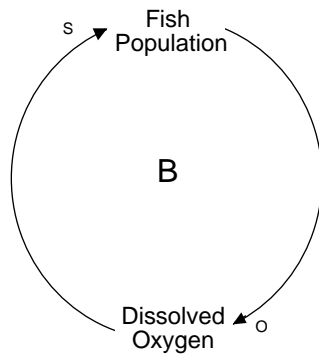


Two mental models of practice and performance:



CLD - High School Chemistry Class

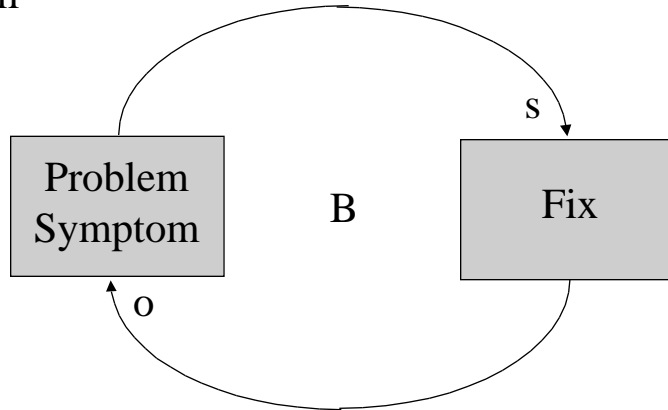
Students discover this balancing relationship as they participate in the water quality simulation.



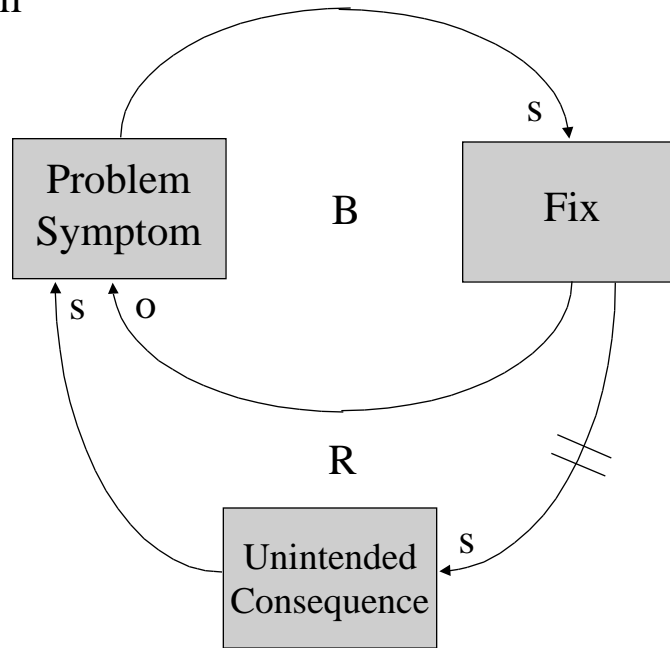
Fixes that Fail

Problem
Symptom

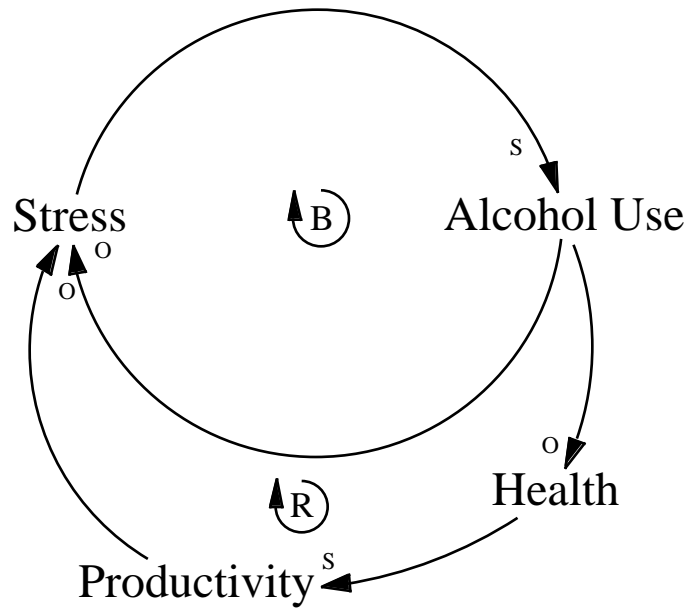
Fixes that Fail



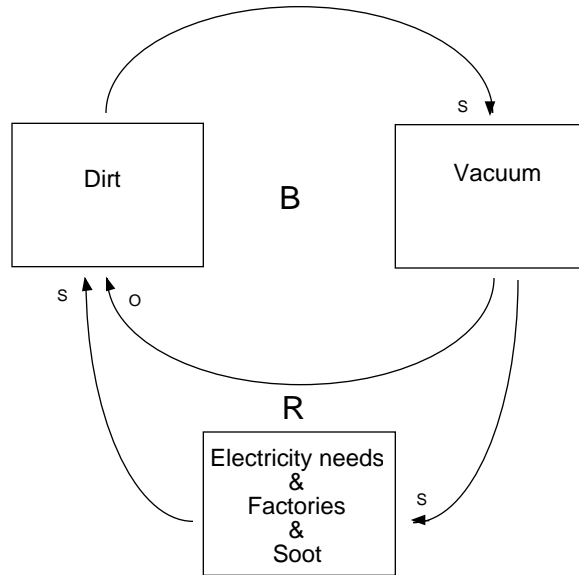
Fixes that Fail



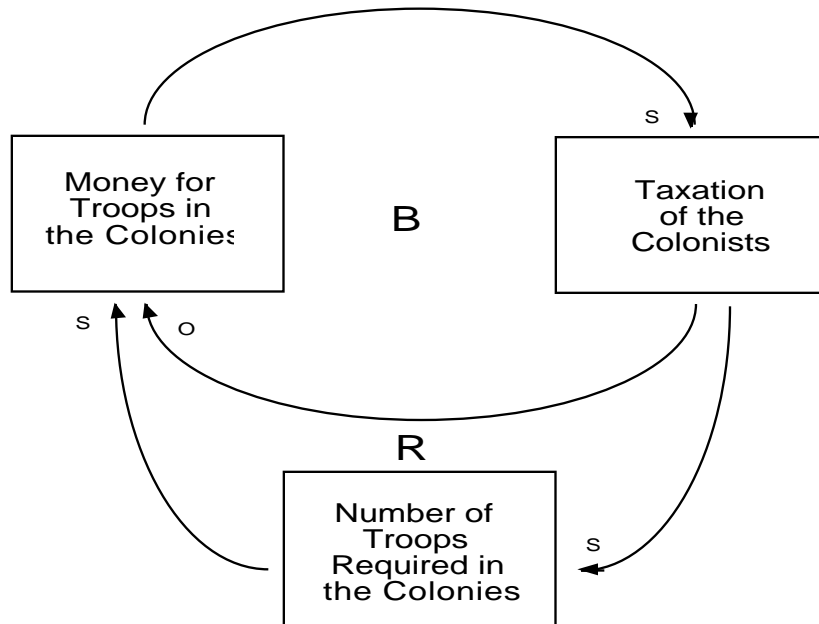
Fixes that Fail - Example



Fixes that Fail



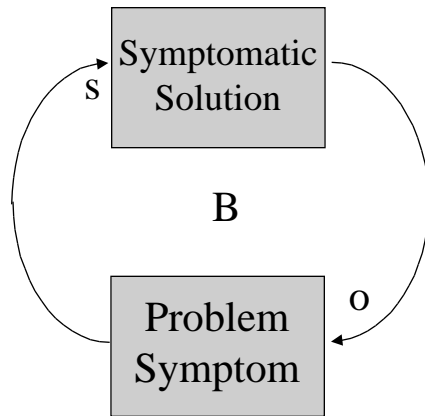
Fixes that Fail - Elementary School Social Studies

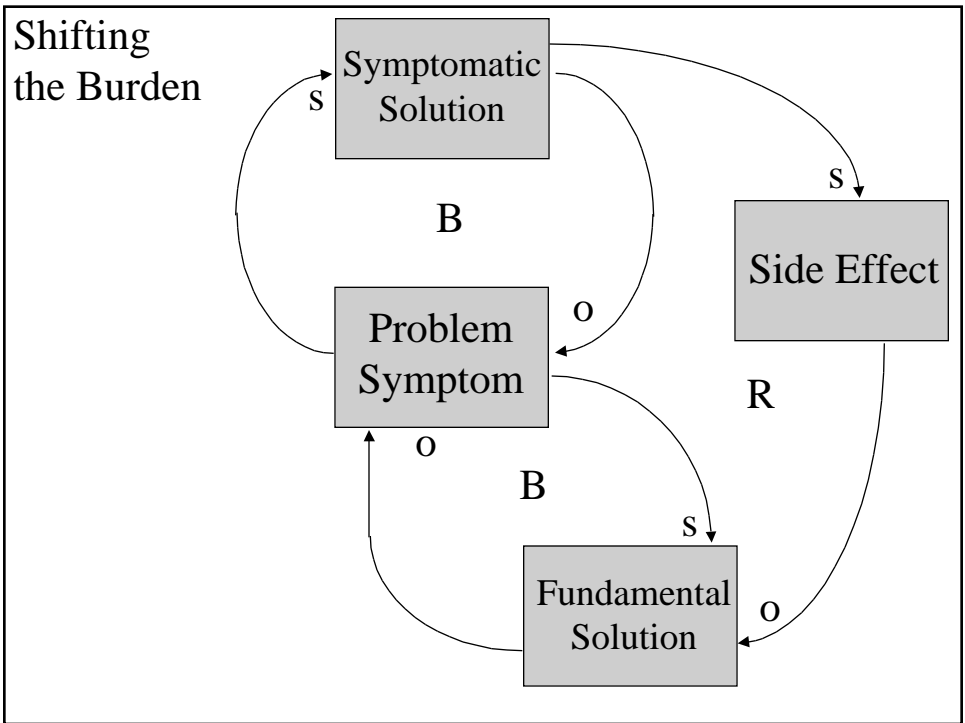
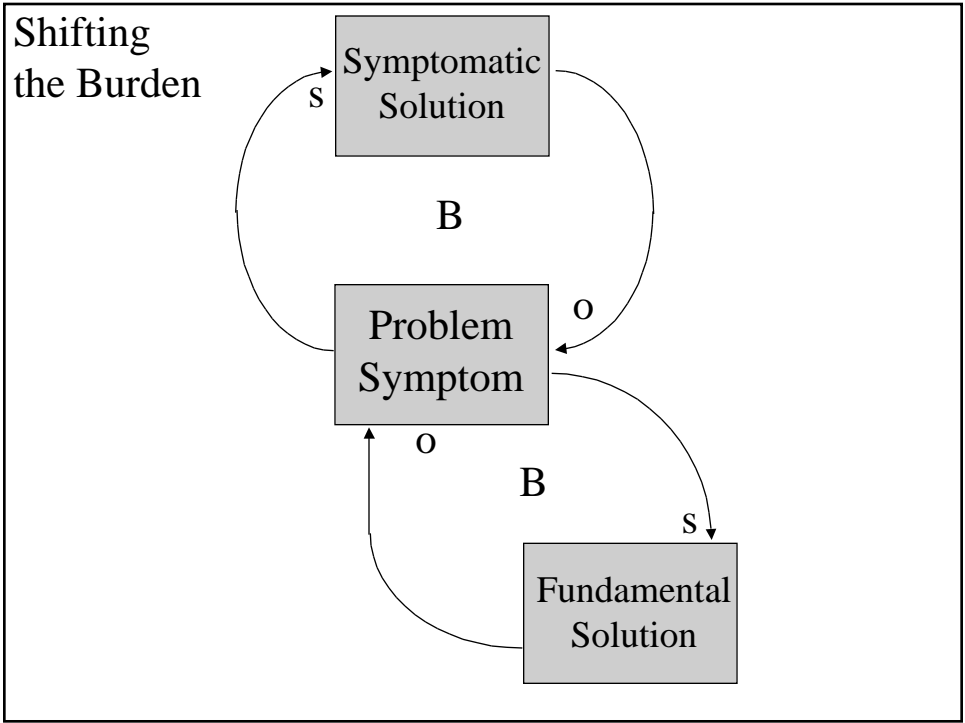


Shifting
the Burden

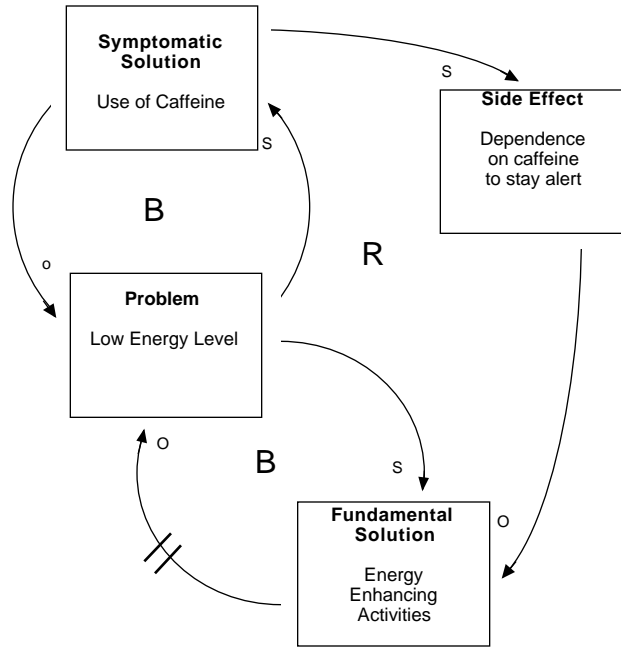
Problem
Symptom

Shifting
the Burden

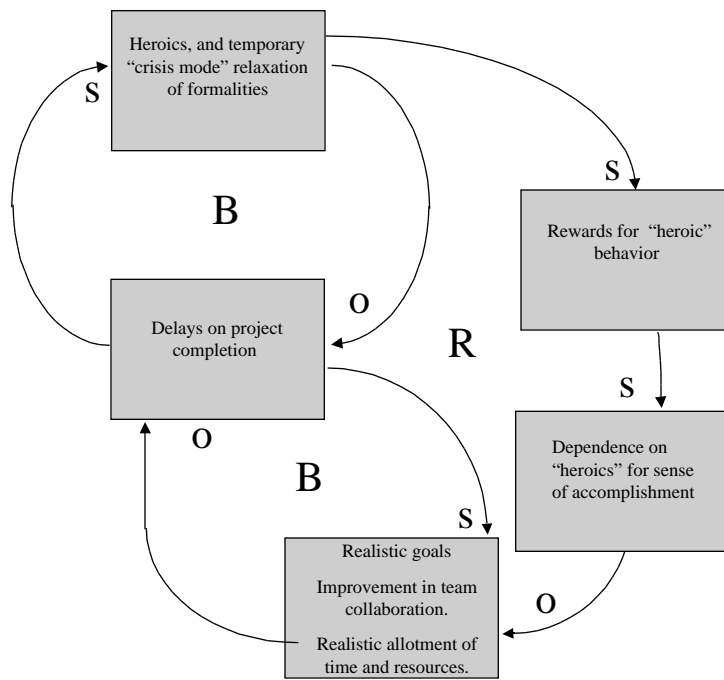


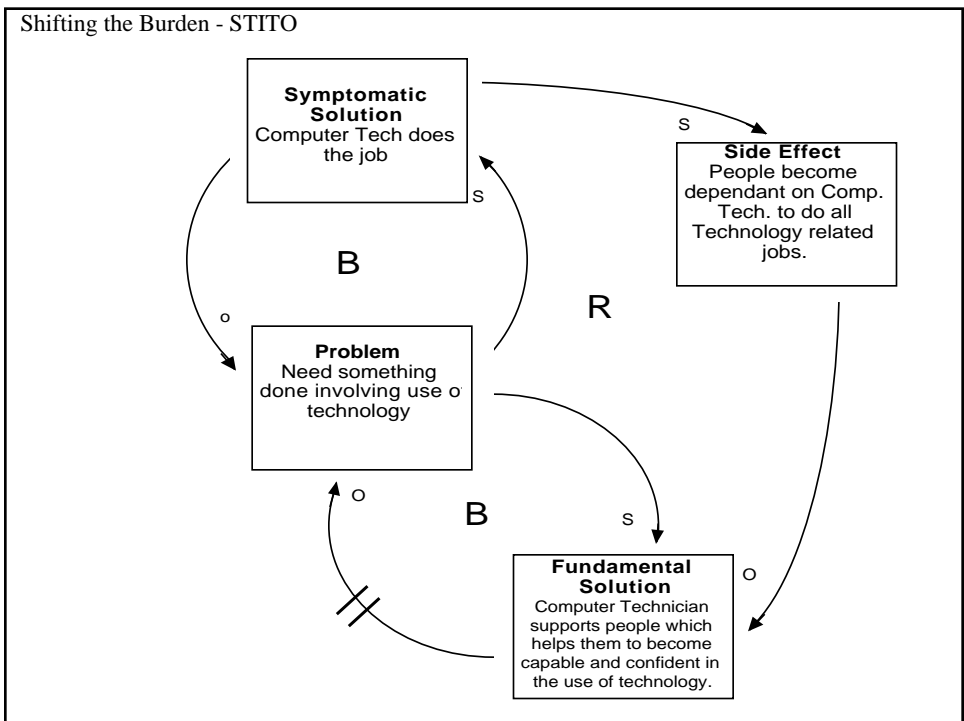
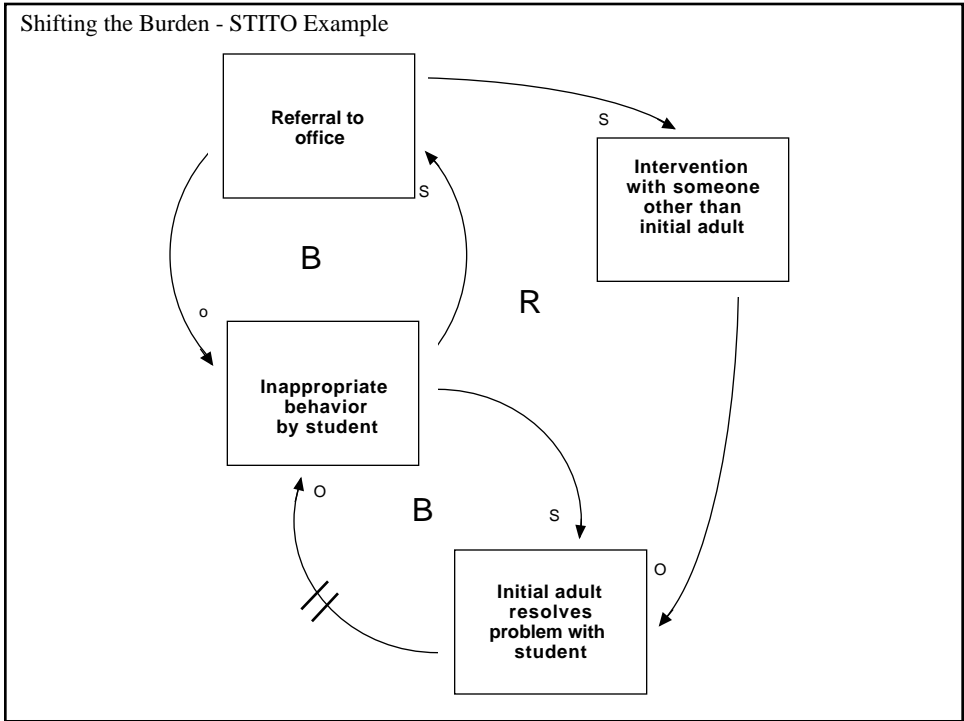


Shifting the Burden - Example



Shifting the Burden





Escalation

Threat
to A

Escalation

Threat
to A

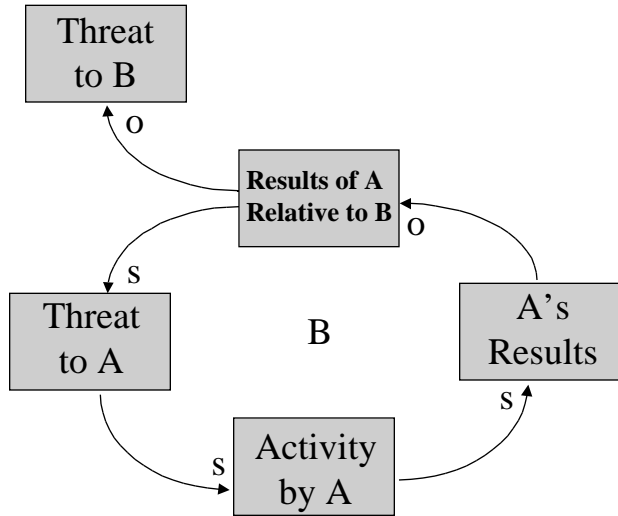
Activity
by A

A's
Results

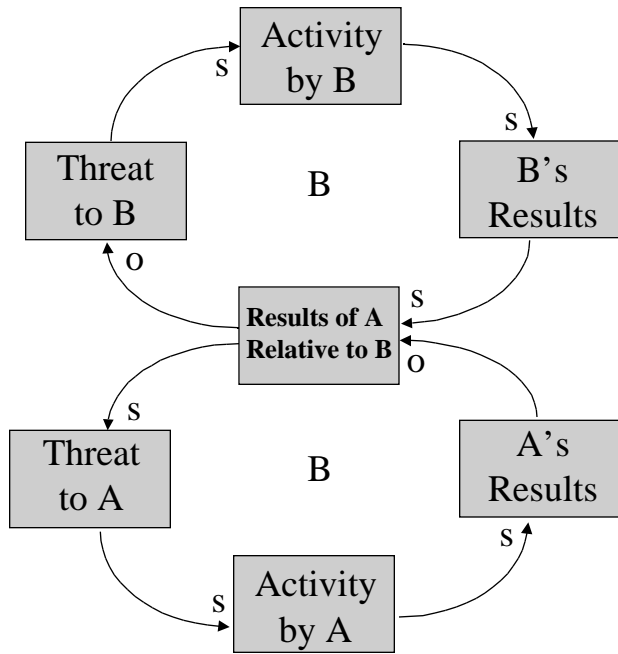
s

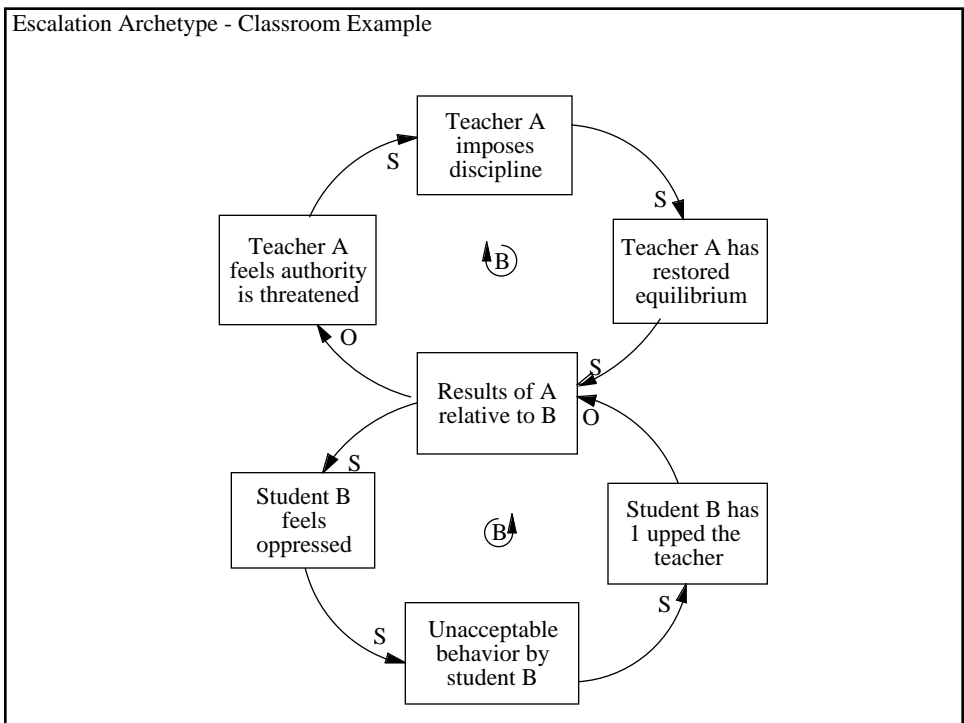
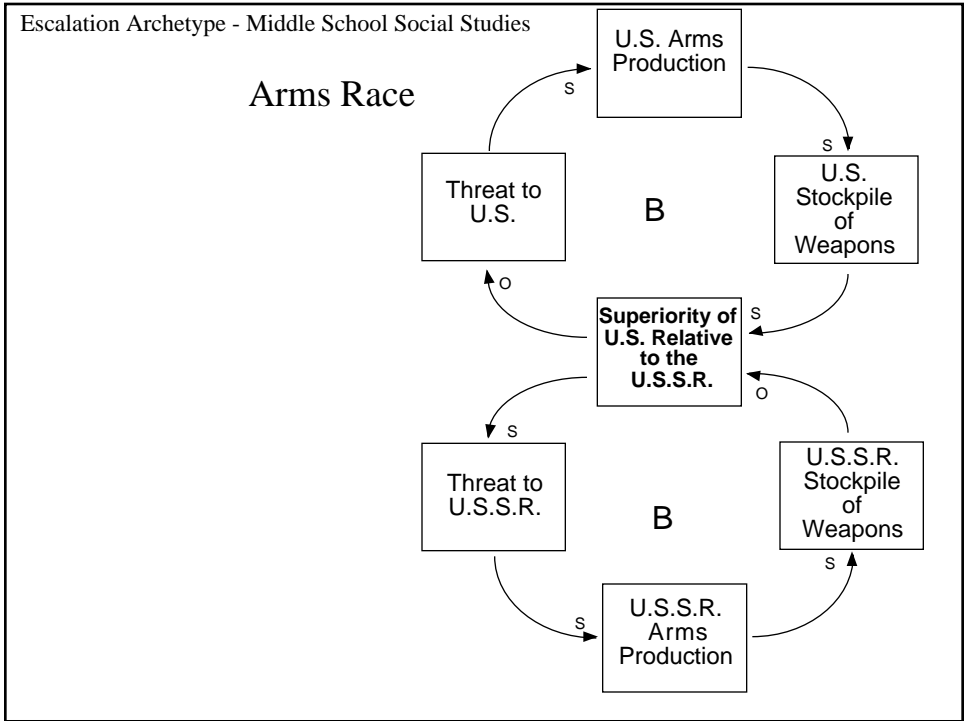
s

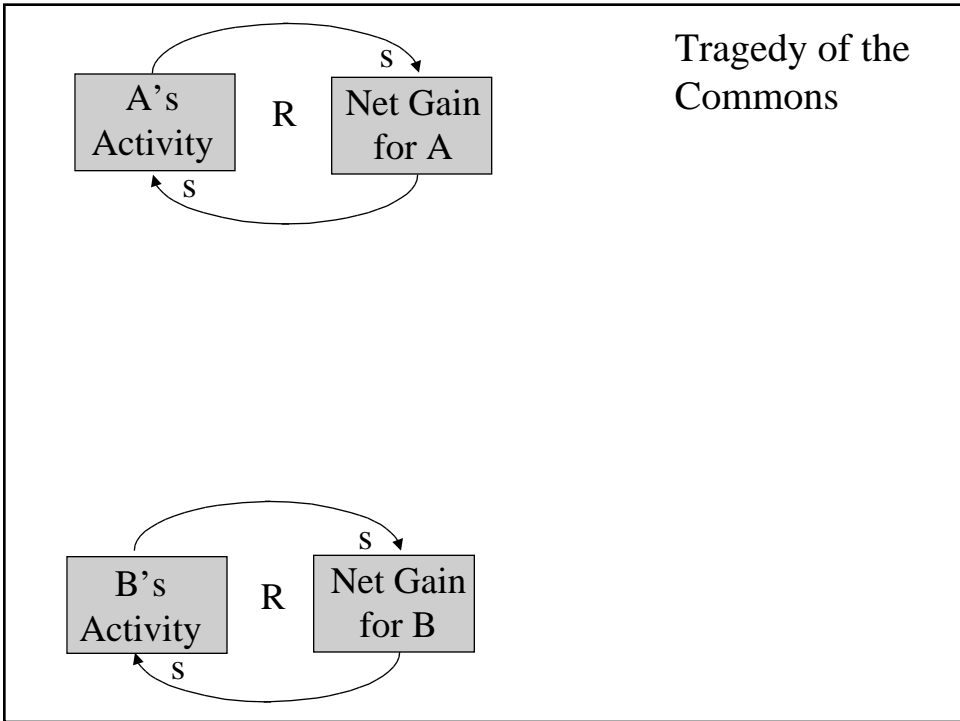
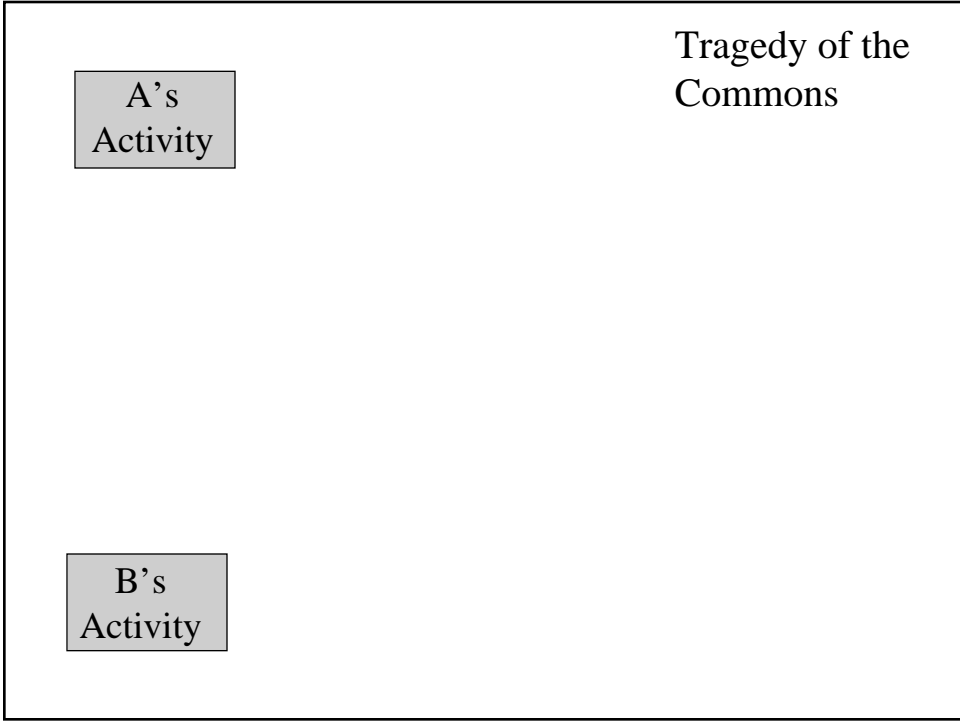
Escalation

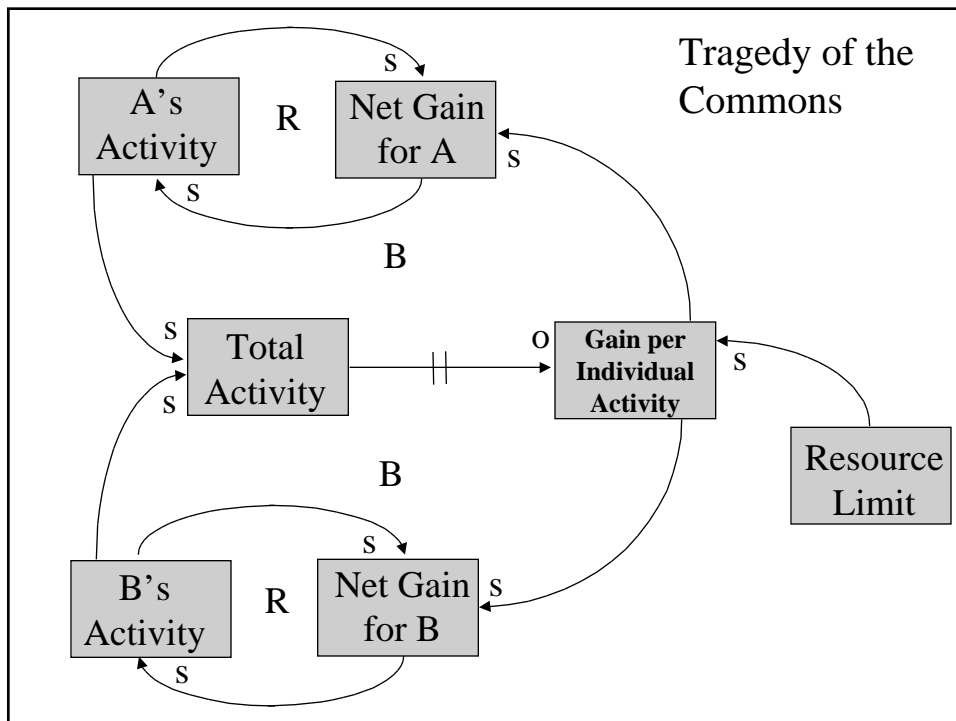
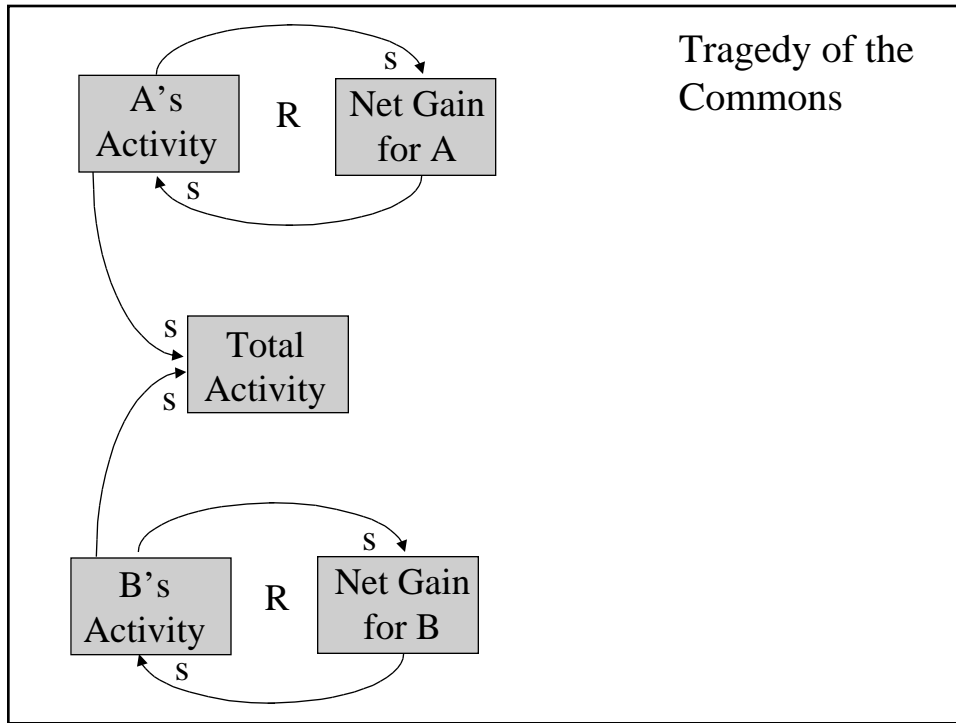


Escalation

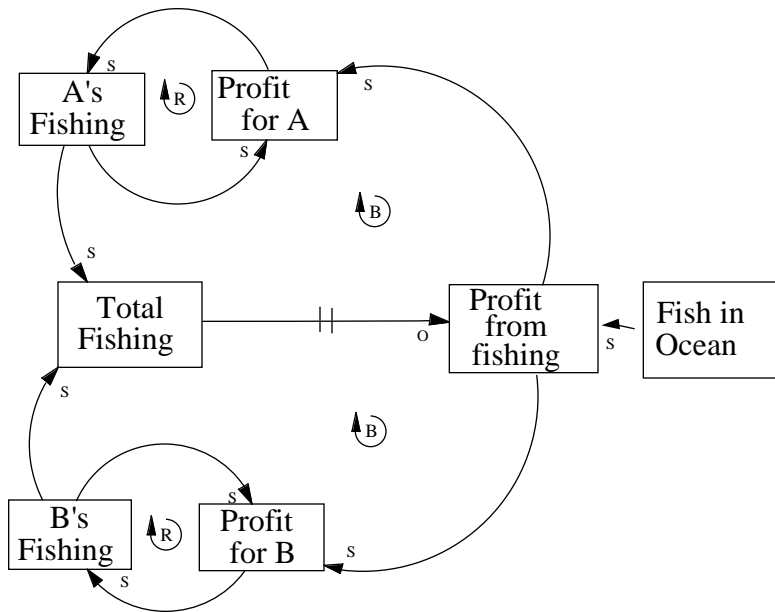








Tragedy of the Commons - Middle School Science



Stock/Flow Diagrams (S/FDs)

S/FDs show interdependencies within a system. They help us:

- identify that a system of interdependent parts exists within specified boundaries
- analyze and understand the interdependencies among parts of a system, particularly feedback relationships (how something that was initially an “effect” ultimately becomes a “cause”)
- analyze and understand the conditions that create/affect the interdependencies
- analyze and understand the cumulative effects over space and time that are caused by the interdependencies

Relative to a goal:

- determine and understand the choices available within a system and the inherent trade-offs that result from those choices
- identify short and long-term effects of the trade-offs within a system
- make decisions and take action based on an understanding of the trade-offs and the accumulations over time within a system

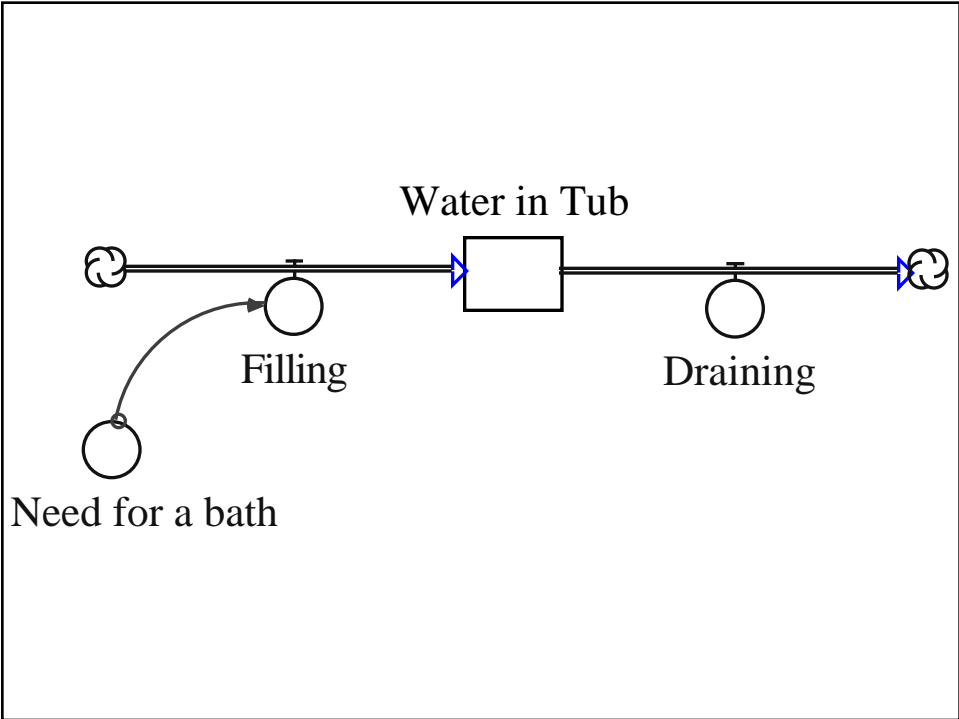
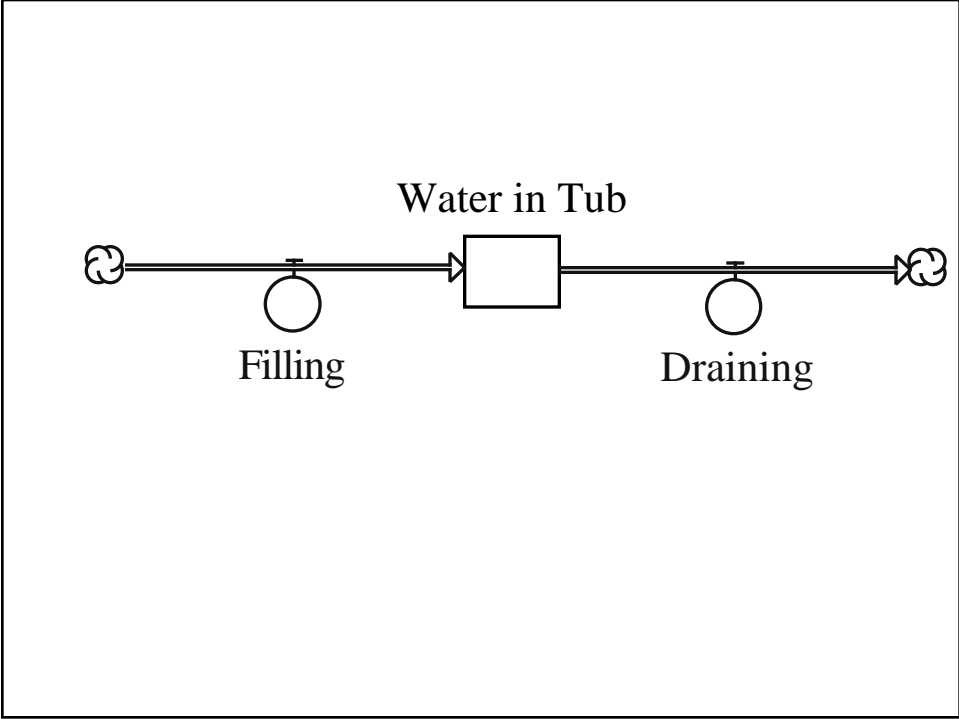
Water in Tub

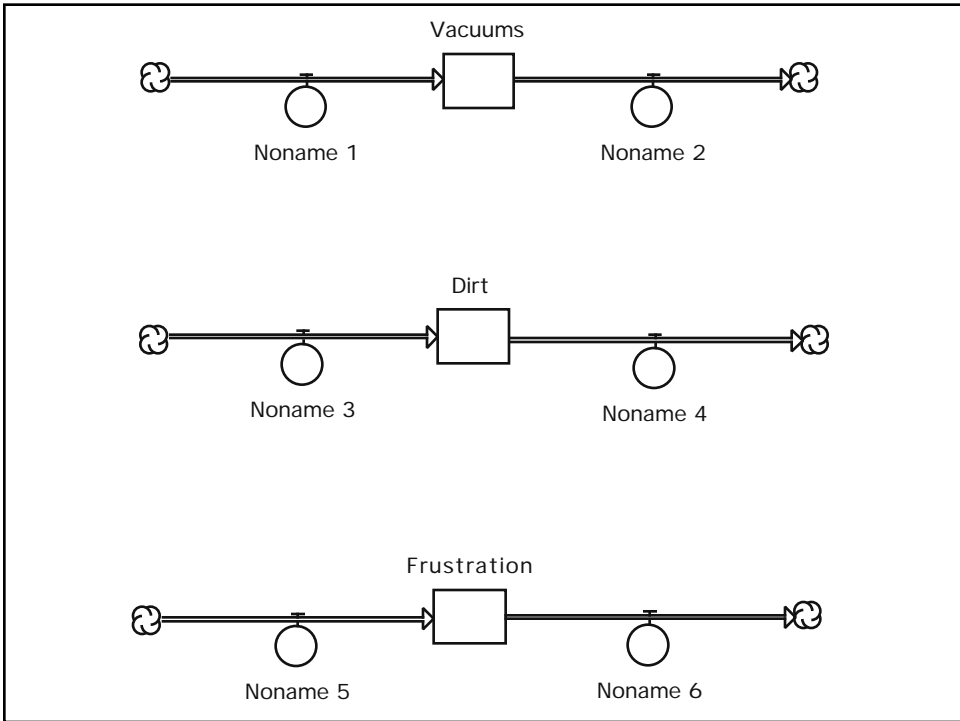
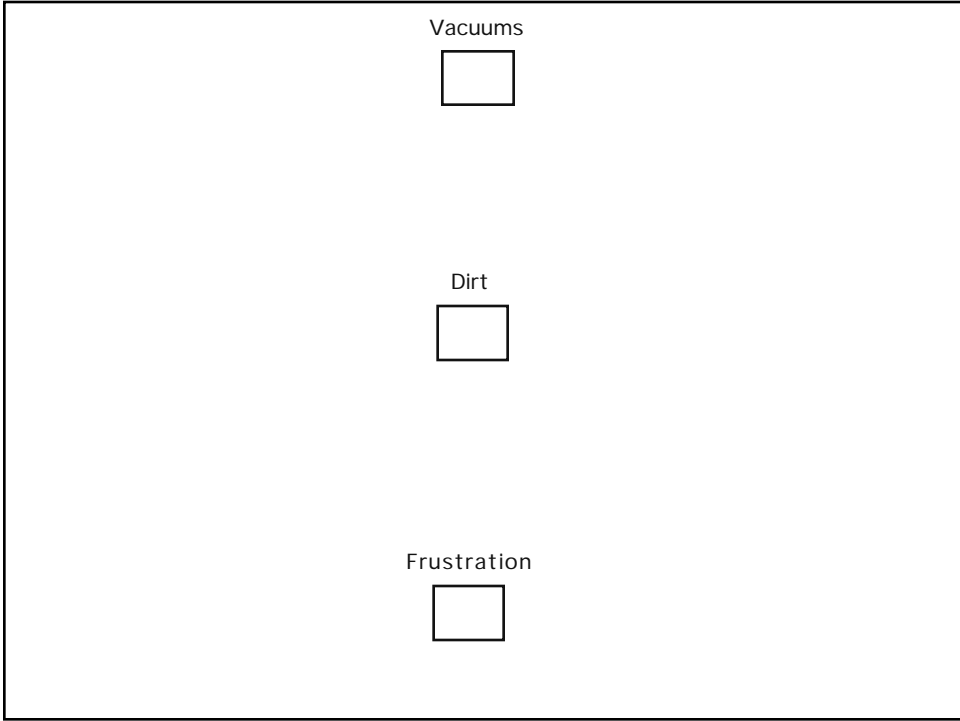


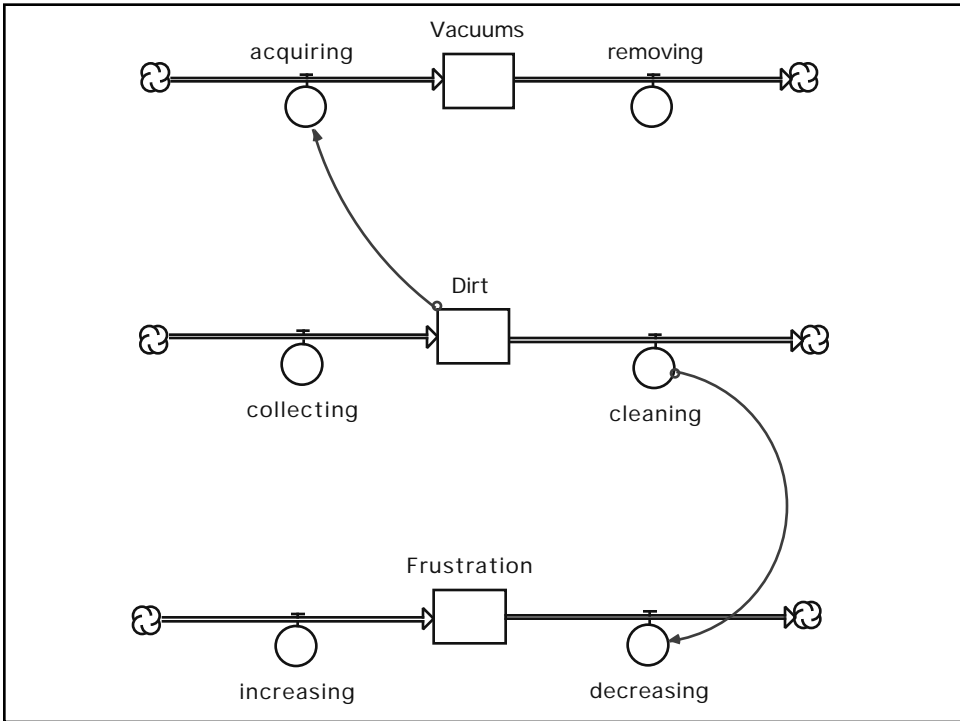
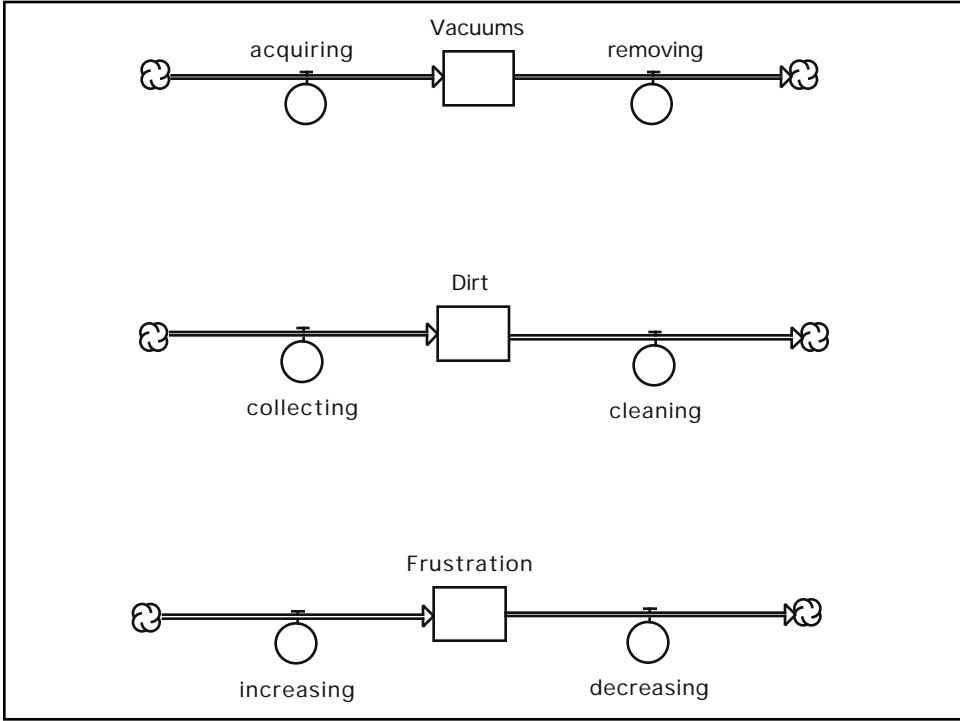
Water in Tub

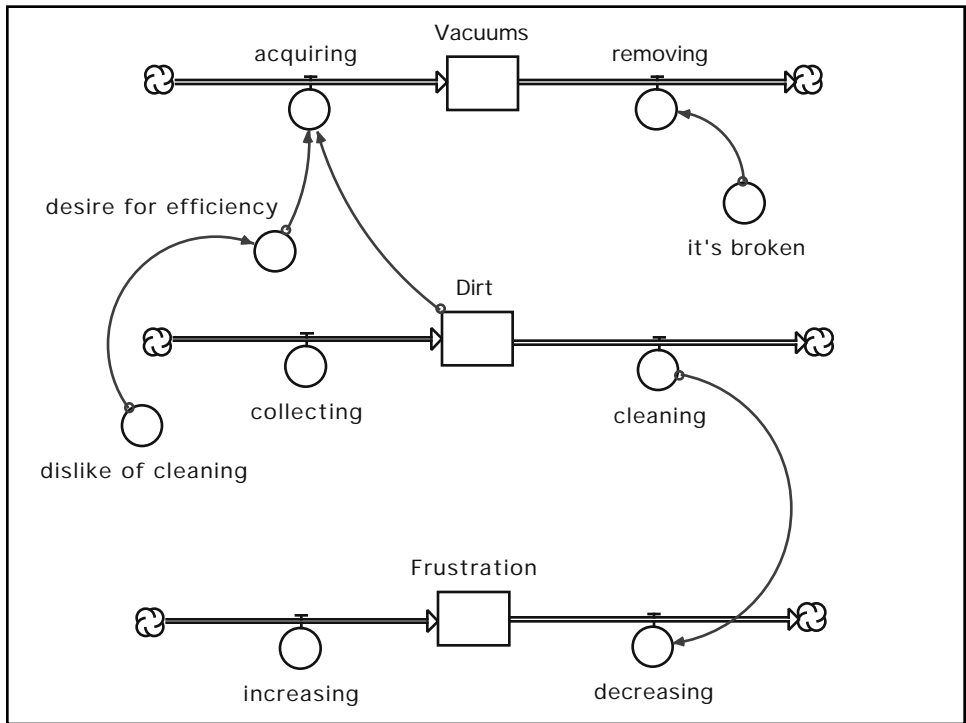
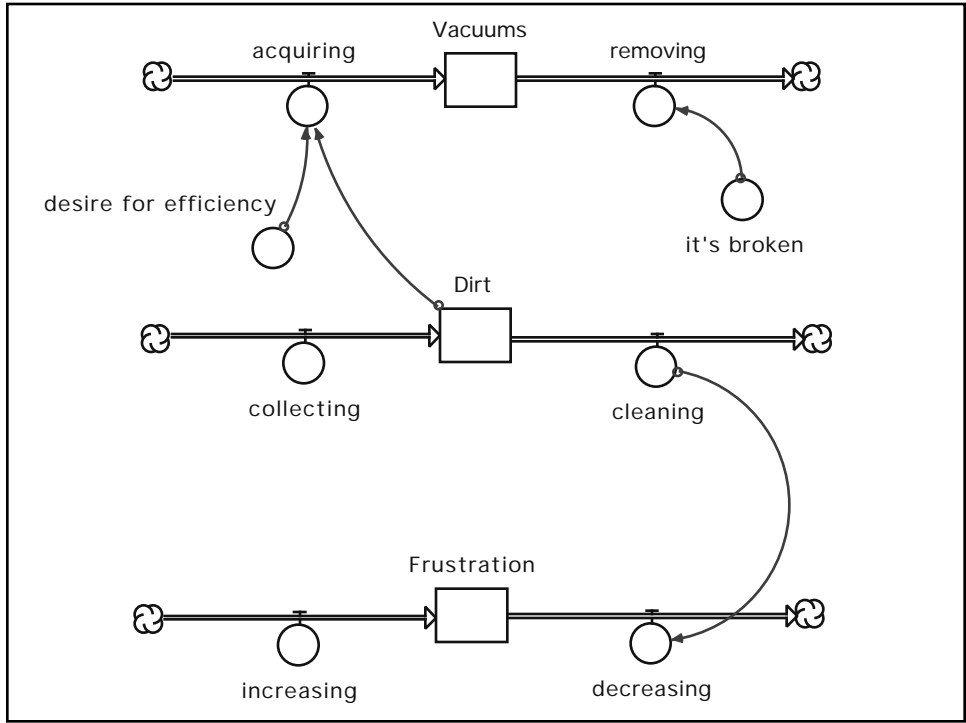


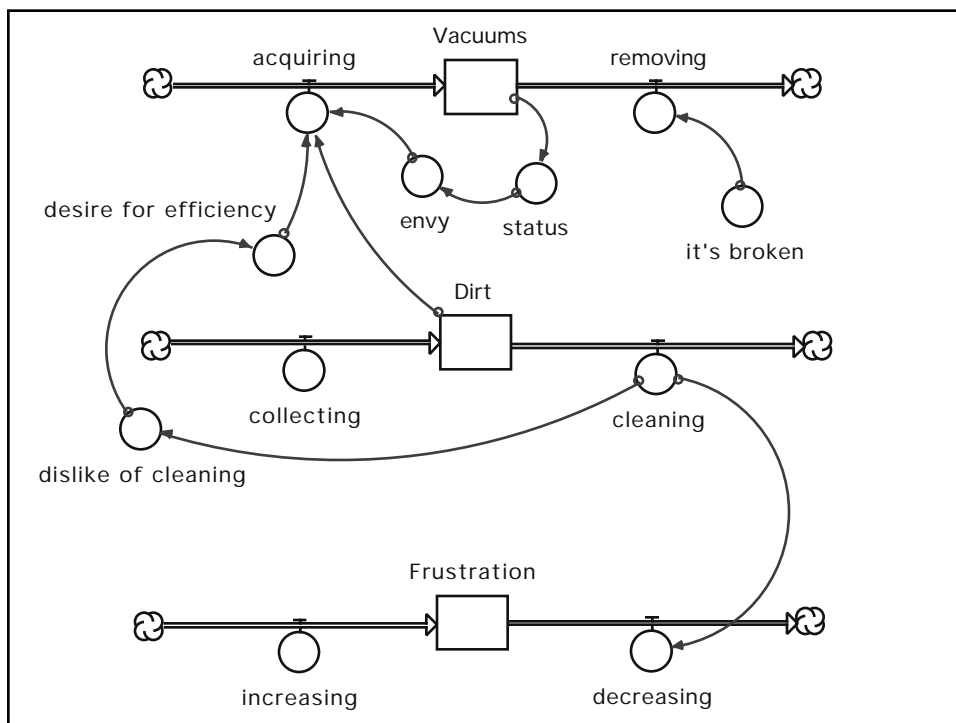
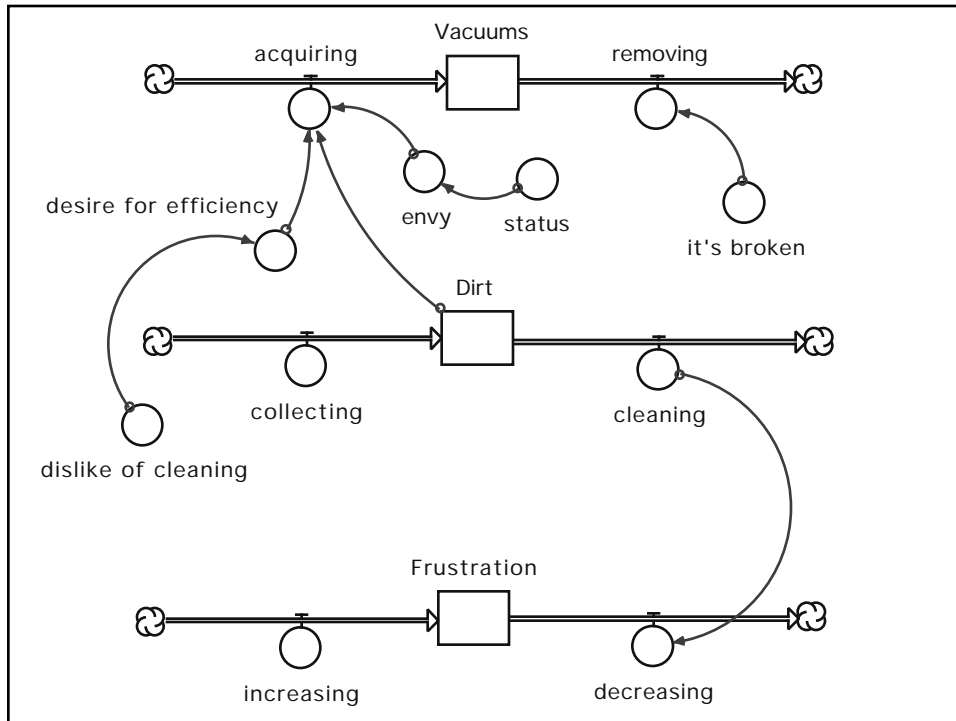
Filling





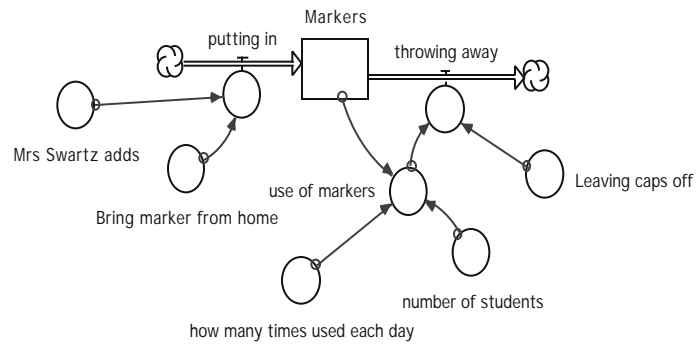






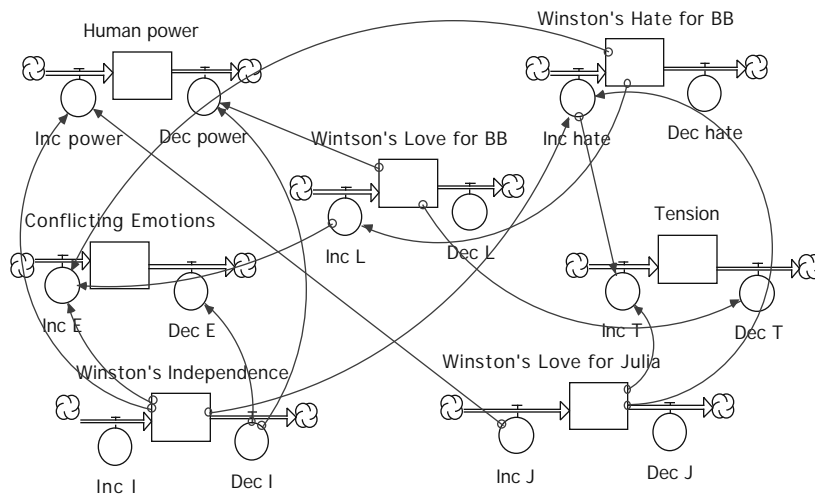
Stock/Flow Map - Elementary School Social Studies -2nd Grade Mini Society Unit

One objective of the Mini Society unit is for students to understand the concept of scarcity. This S/F map was used to examine the accumulation and drain of markers in the 2nd grade classroom.

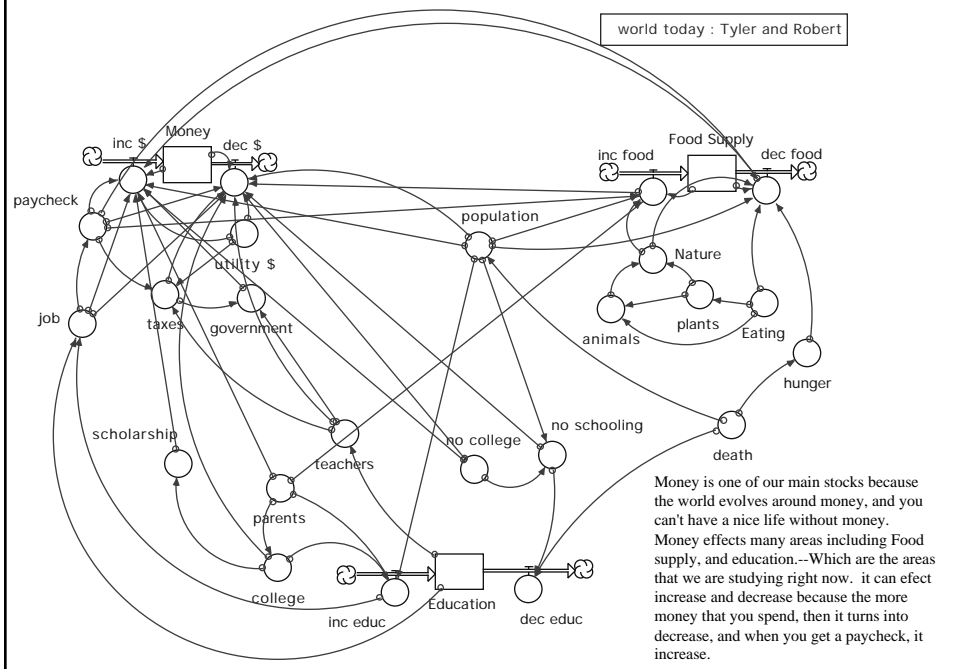


Stock/Flow Map - Middle School Literature

1984



Stock/Flow Map - Middle School Literature



System Dynamics Computer Models/Simulations

- **Models/simulations show how a system operates, what the likely effects of an action would be, and allow us to ask, “What if?” They help us:**
- **identify that a system of interdependent parts exists within specified boundaries**
- **analyze and understand the interdependencies among parts of a system, particularly feedback relationships (how something that was initially an “effect” ultimately becomes a “cause”)**
- **analyze and understand the conditions that create/affect the interdependencies**
- **analyze and understand the cumulative effects over space and time that are caused by the interdependencies**

Relative to a goal:

- **determine and understand the choices available within a system and the inherent trade-offs that result from those choices**
- **identify short and long-term effects of the trade-offs within a system**
- **make decisions and take action based on an understanding of the trade-offs and the accumulations over time within a system**

General purpose:

- Determine how a system operates and what the likely effects of an action would be in a system
- Simulate the effects elements of a system might have on each other over time

Some things to think about:

- Computer models are somebody's "mental model" of the system under study
- Models must have an explicit purpose which helps determine key stocks, as well as time/size boundaries

Practice exercises:

Model Objectives

- Predict, infer, and communicate how populations increase, decrease or stay the same
- Understand how birth rate and death rate affect the level of population through experimenting with birth rate and death rate percentages