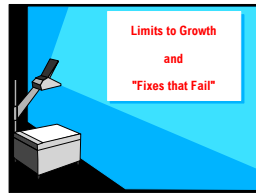


## Systems Thinking for Sustainable Computing

Colorado College - 12/08/03

Bob Powell, Ph.D. MBA  
Continuous Improvement Associates  
E-mail: [scuba@usa.net](mailto:scuba@usa.net) Tel: 719 599-0977  
Web: [exponentialimprovement.com](http://exponentialimprovement.com)



... but it's not as risky as this ...

Indeed:  
"The ability to learn  
faster than your  
competitors  
may be the only  
sustainable  
competitive  
advantage."  
Peter Senge, quoting  
Arie de Geus, in  
The Fifth Discipline,  
1990

## Outline

- Systems Thinking Overview
- Sustainable Computing  
& "Limits to Growth"
- Calls for Service Dynamics  
& "Fixes That Fail"
- From Systems Thinking to Action
- Conclusion

## Systems Thinking Overview

## Classes of problems

- Problems
- Messes
- Wicked messes

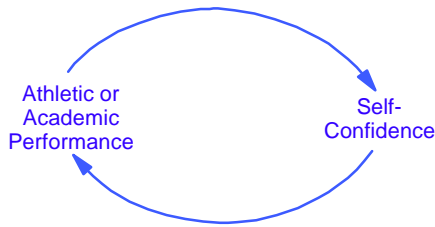
## Complexity Happens

- Examples:
- showering
  - driving

~~Detail~~  
Dynamic

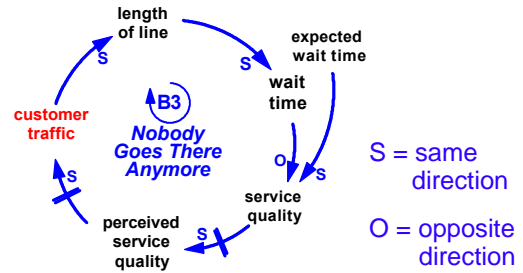
Todd Siler, *THINK LIKE A GENIUS*, 1997, p. 169

## Interdependencies ... What Causes What?

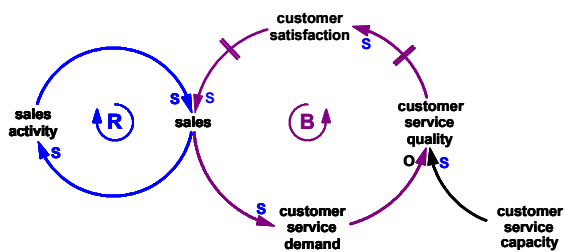


## A Popular Restaurant

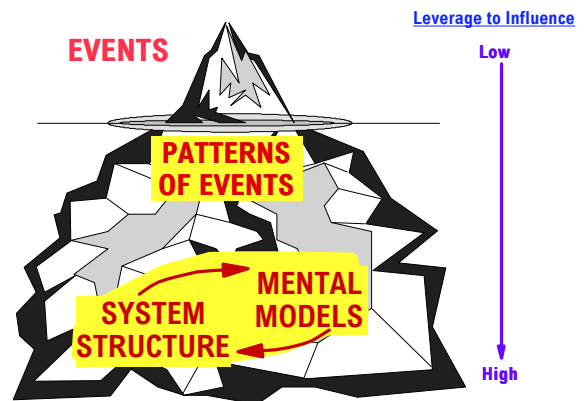
■ "That place is too popular.  
Nobody goes there anymore." Yogi Berra



## A "Limits to Growth" Structure



## System as Cause & System Leverage



## An Example of Structure



## Success and failure

"Success and failure arise primarily as a result of the internal system structure and policies, even where it's clear there was an external cause."

Jay Forrester  
... founder of system dynamics

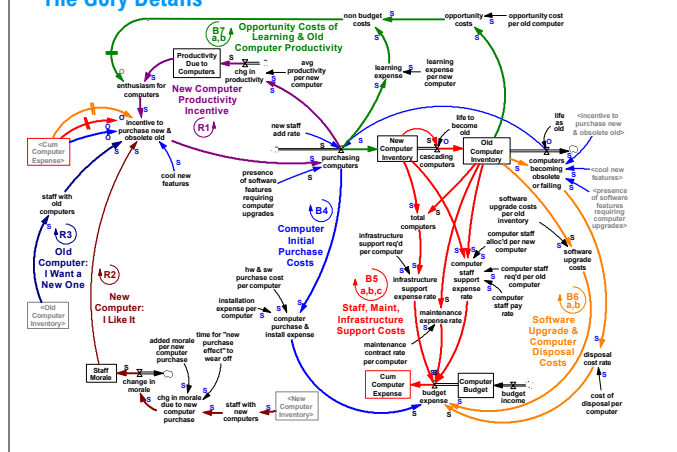
bell

## Sustainable Computing & "Limits to Growth"

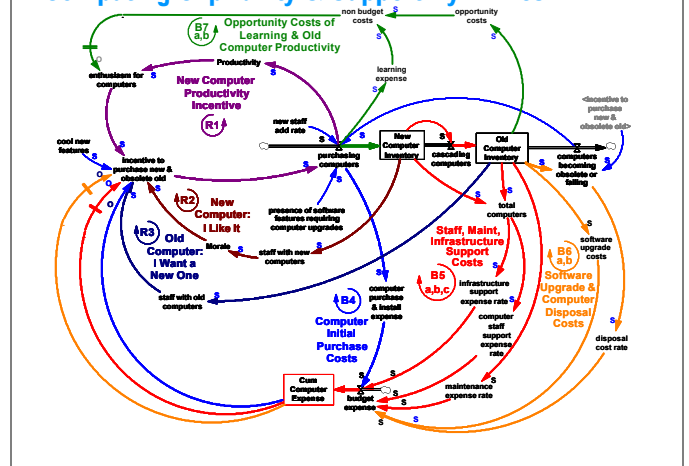
## Focusing Problem Statement: Computing Capability & Support Dynamics

- How can systems thinking ...
- ... contribute to understanding the dynamics of "Sustainable Computing"
- ... and consider the long-term costs and maintainability of a growing computer inventory and increasing associated costs.

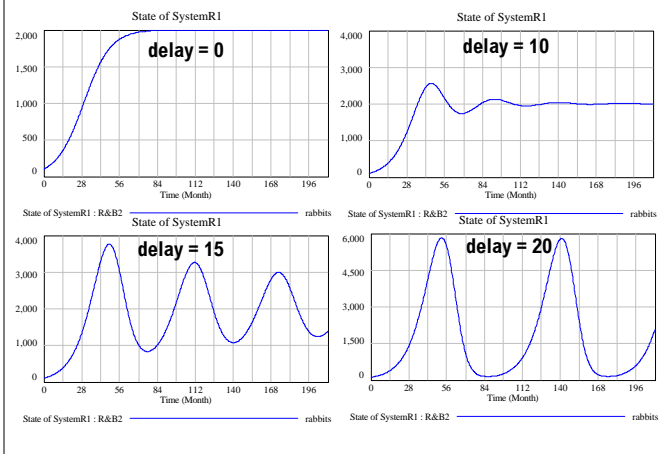
### Computing Capability & Support Dynamics - The Gory Details



### Computing Capability & Support Dynamics



### Limits to Growth Behaviors as Delays Increase

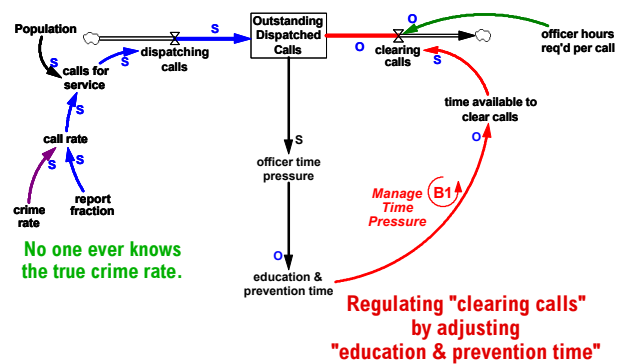


### Calls for Service Dynamics & "Fixes That Fail"

## Focusing Problem Statement Calls for Service Dynamics

- Understand the interactions between officer workload and officer ability to handle Calls for Service (CFS).
- How are call backlog and call response affected by an increasing number of calls with limited resources?

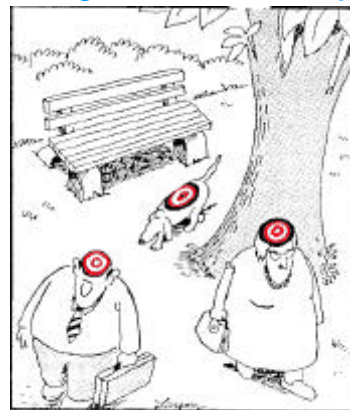
## "Calls for Service" Core Structure



## Interviews: A Surprising Contradiction

- Interview objective:  
Ask the officers to define the relationship between "education & prevention time" and the number of "CFS."
- Surprise
  - ➔ One officer indicated that CFS would go up with more "education & prevention time"
  - ➔ Another officer indicated CFS would go down.
- How do we understand this contradiction???

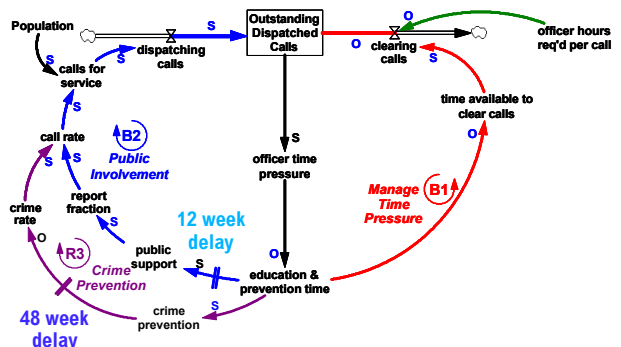
## Making Mental Models Explicit:



## The Resolution

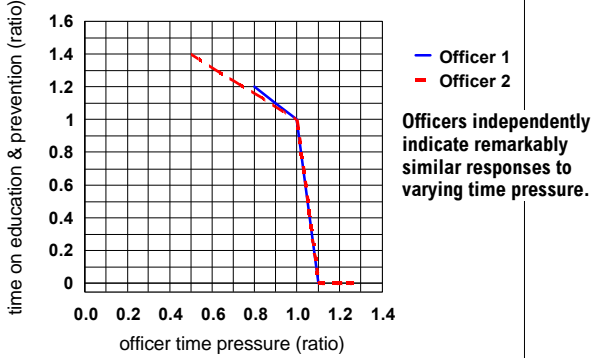
- Calls for Service result from both the number of crimes and the rate at which those crimes are reported.
- Officer input led us to include two effects:
- Initially (time frame 12 weeks), calls would increase. Working with the community leads citizens to believe their reports will make a difference. They will report incidents they might not otherwise report.
- Later (time frame 48 months), calls will decrease because work with the community will prevent crimes and lower the crime rate.

## Basic "Calls for Service" Feedback

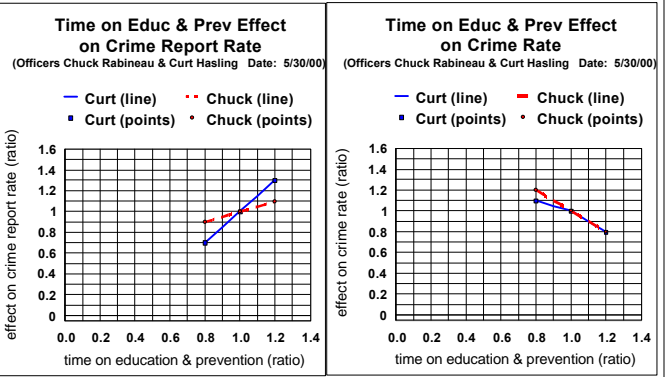


## Officer Response to Time Pressure

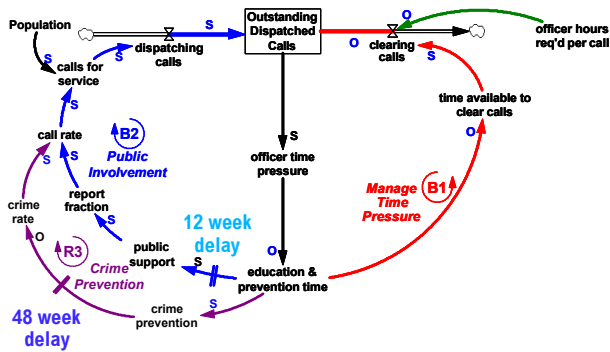
Officer Time Pressure Effect on Educ & Prev Time  
Date: 5/30/00



## The Two Effects of "Time on Education & Prevention"



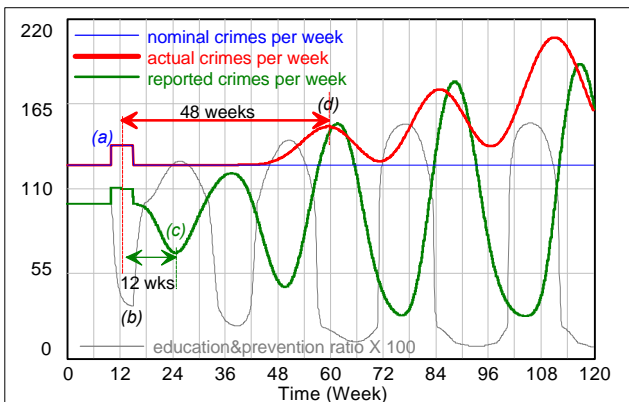
## Simulating the Model



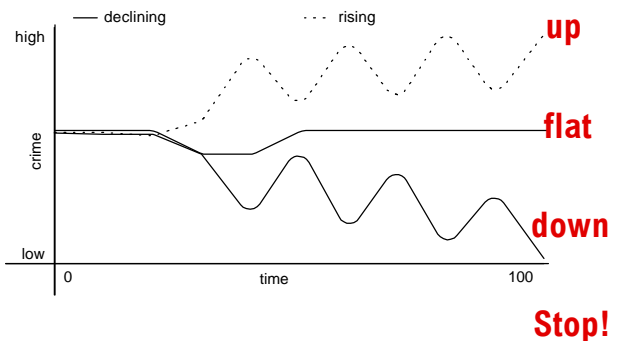
## Simulation Setup

- Set the number of "actual crimes per week" to 125 (.25 crimes/1000 population, population 500,000).
- An 80% report rate gives 100 crimes reported / week.
- Put the model in "steady state"
- At week 10, for a 5 week pulse, increase "actual crimes per week" by 10% from 125 to 137.5.
- Result: 110 crimes / week reported during the pulse.
- What will be the response?

## Positive Pulse Simulation



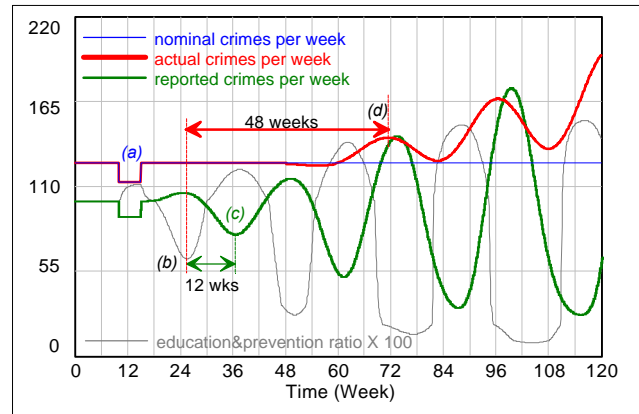
## For a Negative Pulse ... what will happen to crime?



## For a Negative Pulse ... what will happen to crime?

- What is your intuition about what would happen to the long-term crime rate with a negative 10% pulse?
- That is, what happens if actual crime goes down at week 10 by 10% for 5 weeks and then returns to its previous "steady state" value?
- Going on intuition, after a dip in the crime rate, what behavior would you expect
  - downward trend?
  - return to equilibrium?
  - upward trend?

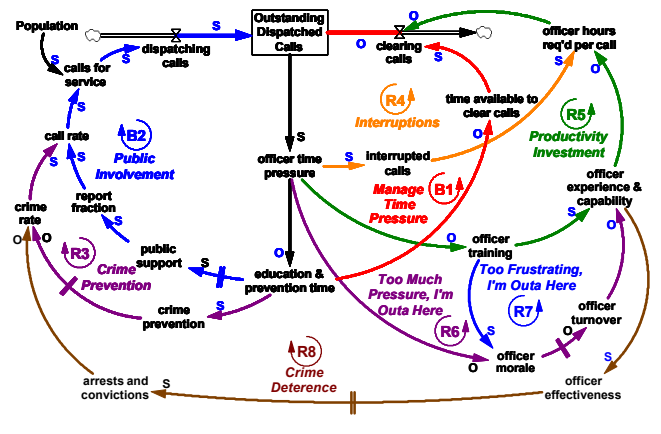
## Positive Pulse Simulation



## So What Do We Learn?

- Complex systems are perverse!
- If the system is near equilibrium, then the response to a temporary fluctuation (increase or decrease!) in CFS may set off an increasing cycle of crime.
- Because of delays and natural, random fluctuations, it's most likely that **no one** would make a connection to the original temporary fluctuation that set it off.
- The learning is to not get too close to equilibrium, to **maintain some excess capacity in the system**, to avoid the possibility that a random fluctuation could set off increasing cycles of crime that would require major expenditures to counteract.

## More "Calls for Service" Feedback



## From Systems Thinking to Action

## Strategy Matrix: Functions vs. Key Success Loops & Driving Forces

Group or Individual	Key Success Loops & Driving Forces					Summary of Strategy for each Function
	Loop R1a,b	Loop B2	Loop R7	Loop XX	Driving Force YY	
General Manager	Compete on Integration Performance	Performance Premium Price Erosion	Most Demanding Customer Shift to Modules			
QA						
Engineering						
Human Resources						
Other						
Summary of Strategy for Each Loop or Driving Force						

... adapted from Clayton Christensen, "Making Strategy: Learning by Doing," *Harvard Business Review*, Nov/Dec 1997

### Practical Systems Thinking is Organic



the reinforcing processes.

... and pull the weeds!

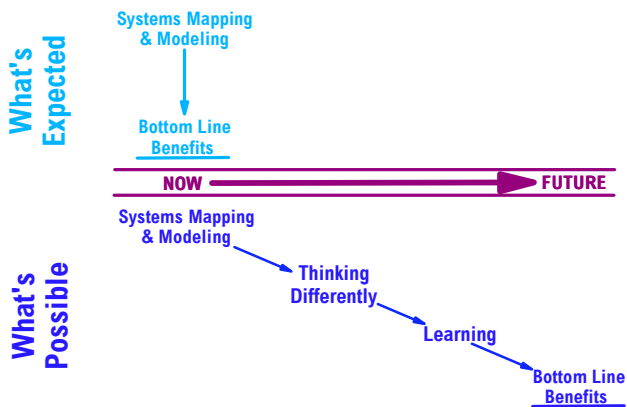
... of the balancing processes

For improved performance!



### Conclusion

### When System Thinking Benefits Show Up



### Systems Thinking: We make it look easy ... and it's fun, too!

