Insightful Little Models

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...not what I had in mind...

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Focusing Questions

- How do "systems thinkers" think?
- How do models help?
- What's the point?

- The point is INSIGHT.

Kinds of Systems Insights

- Dynamic insights
  - Tool: graphs over time
- Structural insights
  - Tool(s): stock-and-flow/causal-loop diagrams
- Systems insights: "Dynamic behavior is a consequence of system structure"
  - Tool: computer simulation

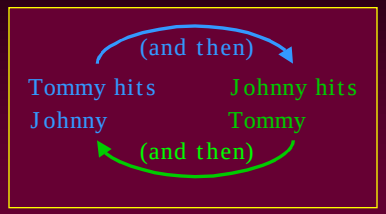
Events, Behavior, Structure

Reactive

Events and Decisions

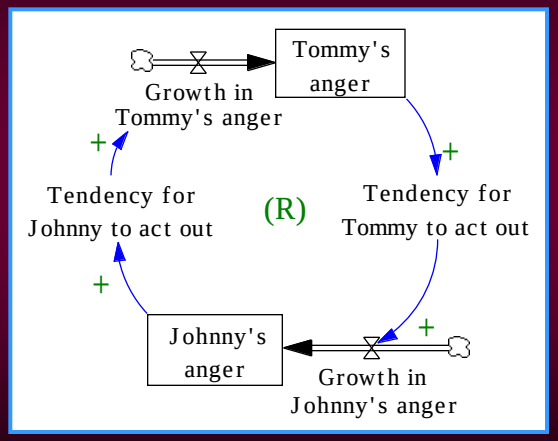
Patterns of Behavior

Event thinking =>

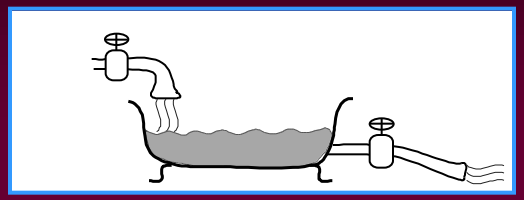


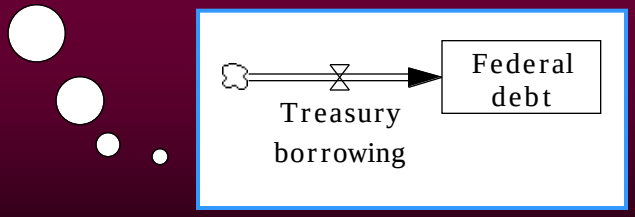
<= Dynamic thinking

A Stock-and-Flow/Feedback View

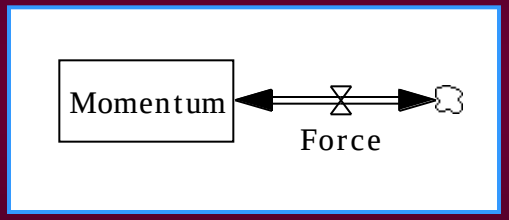


Stocks and Flows

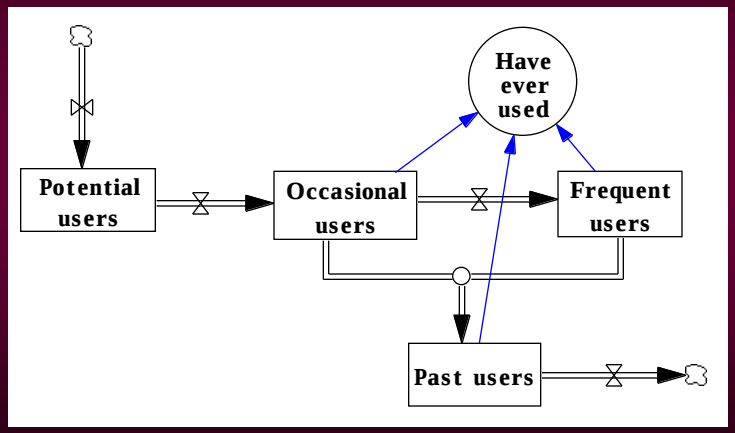




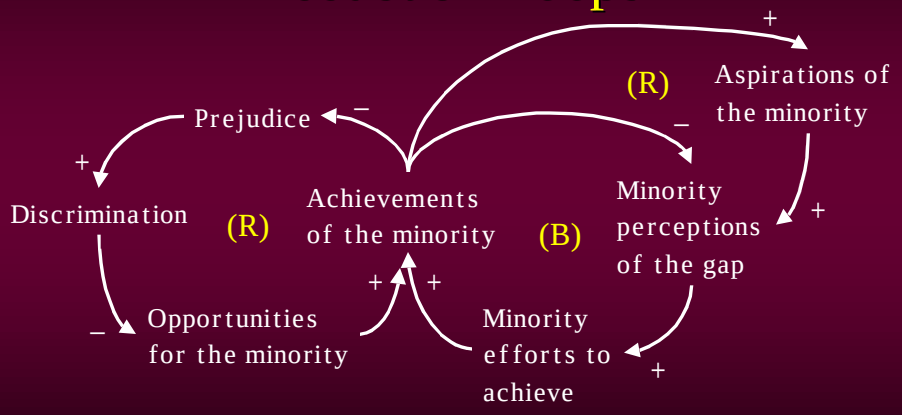
Newton's Stock-and-Flow Insight



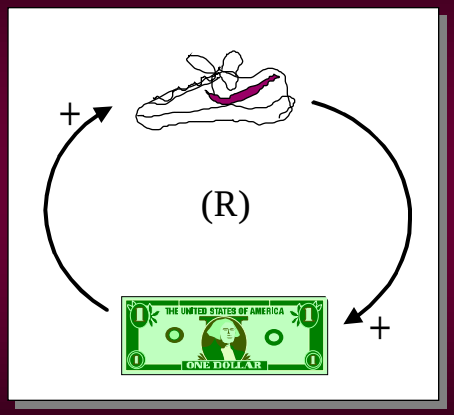
A Drug Researcher's Stock-and-Flow Insight



Reinforcing and Balancing Feedback Loops



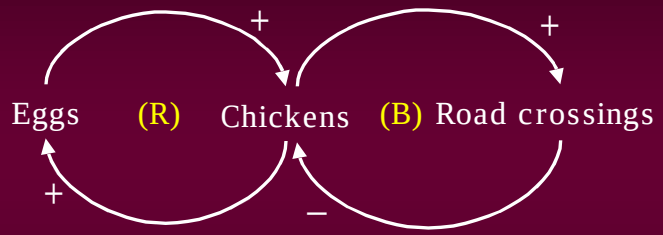
A First-Grader's Feedback Insight



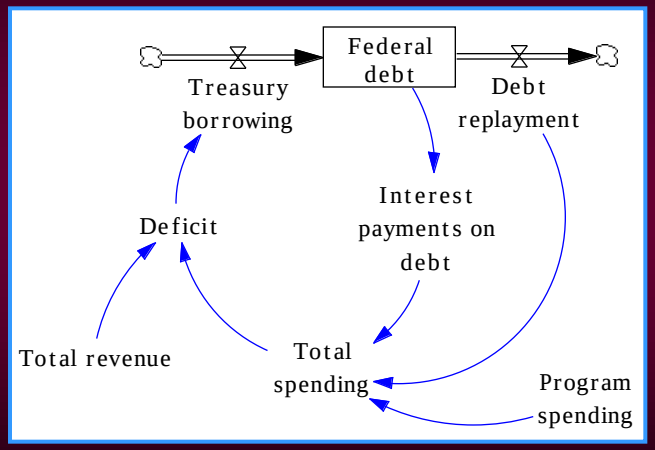
The more shoes Nike makes, the more money they make,

so the more shoes they can make.

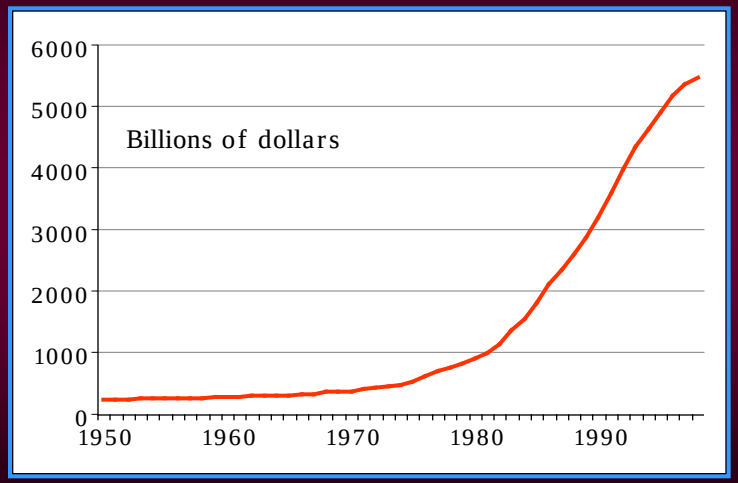
An MIT Professor's Feedback Insight



Deficit and Debt



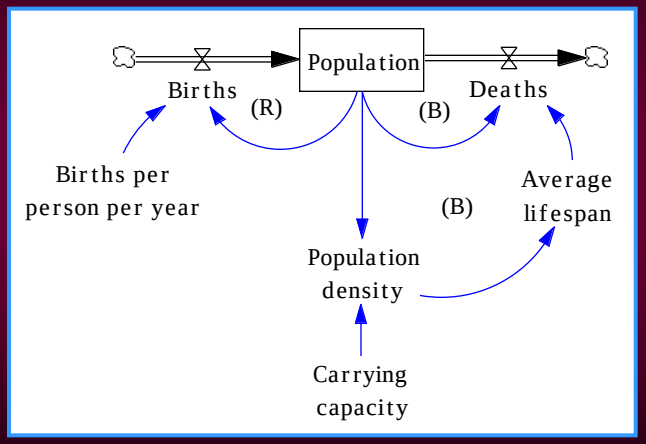
U.S. Federal Debt



Insights from Deficit and Debt

- Debt (a stock) persists through time.
- Deficits (a flow) can be changed (in principle) relatively much quicker.
- The more insistent the Stocks underlying the Deficit, the harder it is to balance the budget and bring down the Debt.
- Stocks (accumulations) are the important drivers of system dynamics.

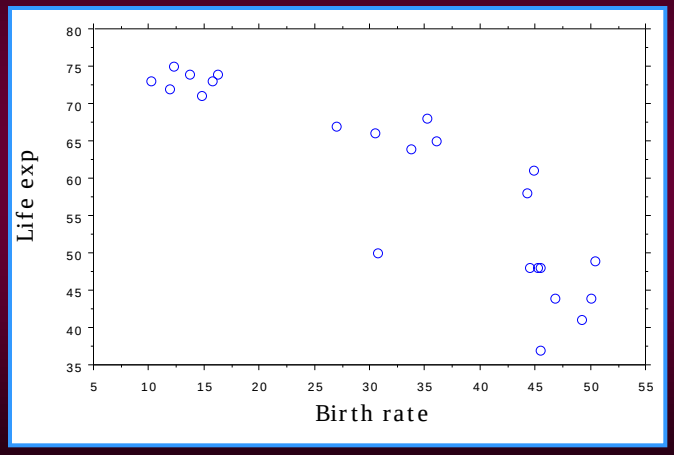
The Message of Malthus



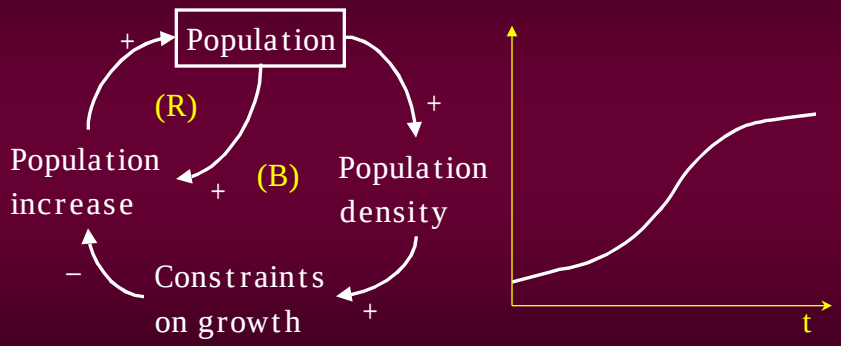
Malthusian Insights

- "Population, could it be supplied with food, would go on with unexhausted vigour, and the increase of one period would furnish the power of a greater increase the next, and this without limit."
- Lowering birth rates, and holding them low, yields the most desirable future.

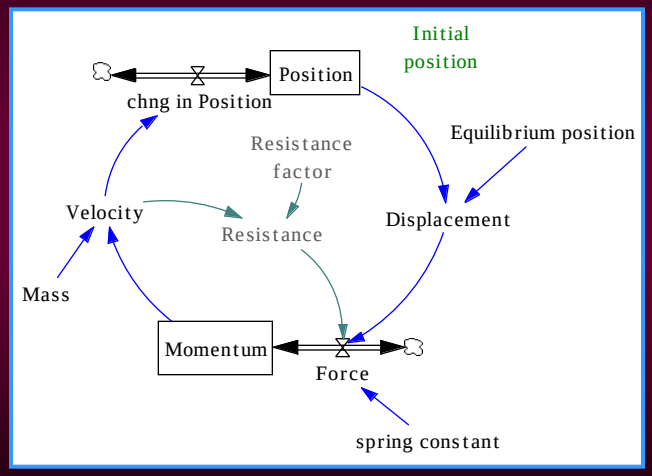
Life Expectancy vs Birth Rate in 23 Countries



“Shifting Loop Dominance” Insight



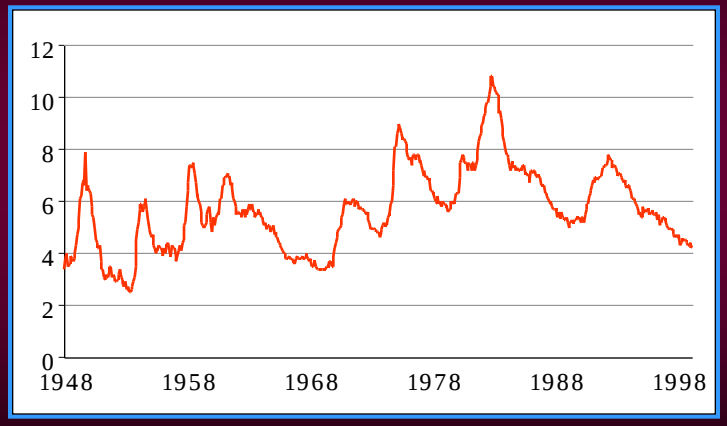
An Oscillating Spring



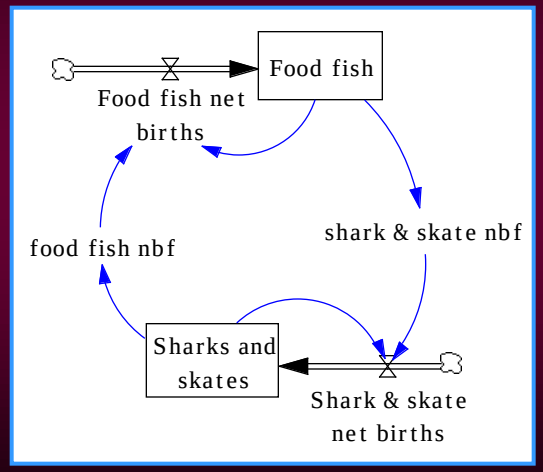
Insights from an Oscillating Spring

- A balancing loop with at least two accumulations tends to oscillate.
- A oscillating system reinforces oscillations from outside that are near its own period.
- An oscillating system stimulated by randomness “hums” at its favorite frequency
- Accumulation smooths out noise.

U.S. Unemployment Rate



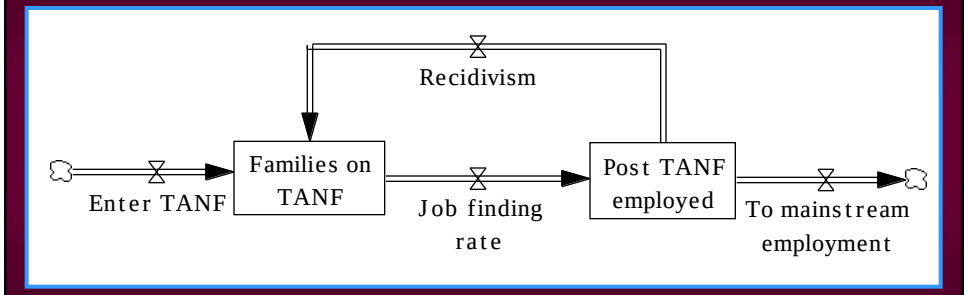
Predator/Prey Ocillations and Volterra's Principle



Volterra's Insight

- Harvesting both food fish and sharks tends to *increase* the average population of food fish.
- Pesticides that harm both pest and its predators can result in larger periodic infestations.

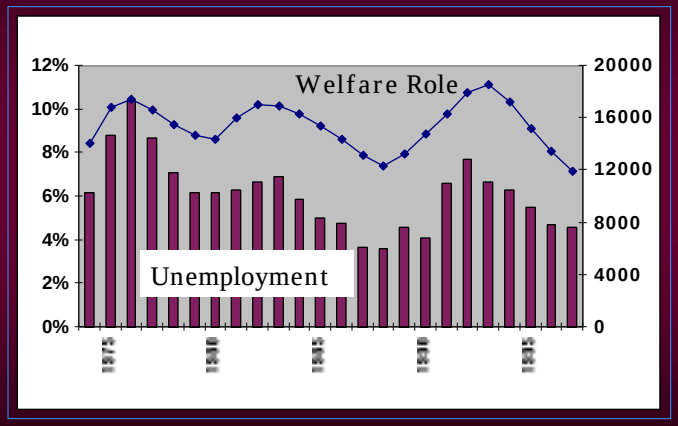
A Social Welfare Archetype



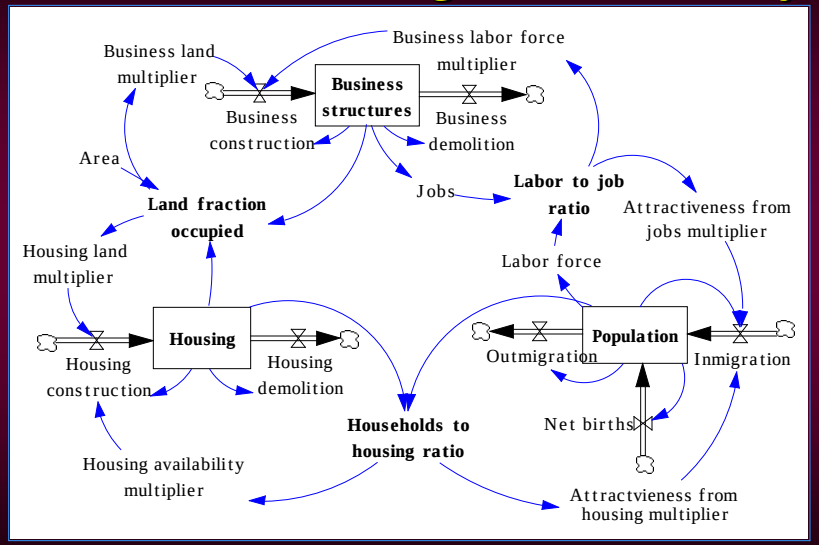
Insights from the Archetype

- Adding capacity upstream can swamp downstream resources.
- Swamping downstream resources can result in more recidivism back upstream.
- Adding capacity upstream, by itself, can actually *increase* the upstream load and make the entire system worse off.

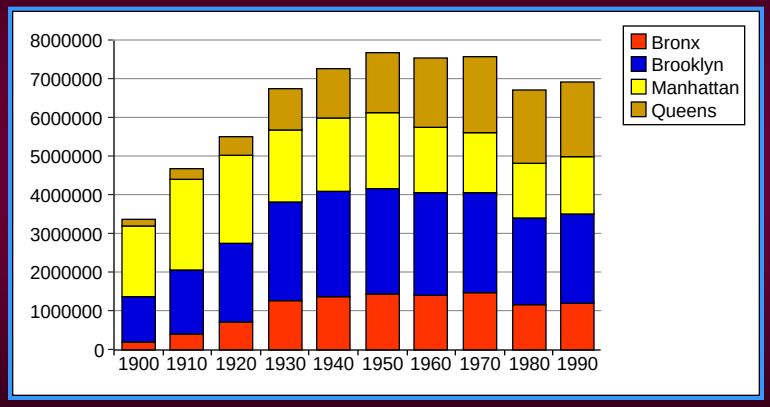
Unemployment & Welfare Roles



Urban Growth, Stagnation, & Decay



New York City Population



Insights from URBAN1

- Cities grow into a fierce competition for scare land.
- The balance shifts from job-generating structures to people-structures, contributing to the economic decline of the inner city.
- Healthy cities must be biased toward job-generating structures.

The Spectrum of Systems Thinking

(after Richmond)

- Dynamic thinking (graphs over time)
- Closed-loop thinking (feedback causality)
- Generic thinking (go for the general)
- Structural thinking (stocks and flows)
- Operational thinking (how does it really work?)
- Continuum thinking (behavior, not events)
- Scientific thinking ("what if" experiments)

But I must admit...

…this guy is a cuter little model.

…but not as insightful.