

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



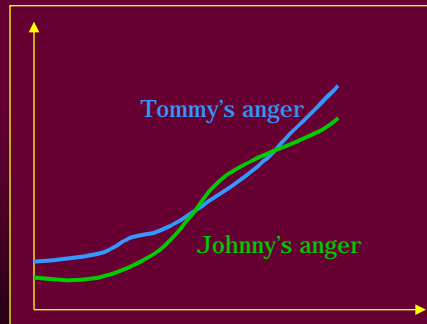
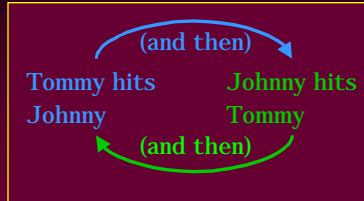
Patterns of Behavior



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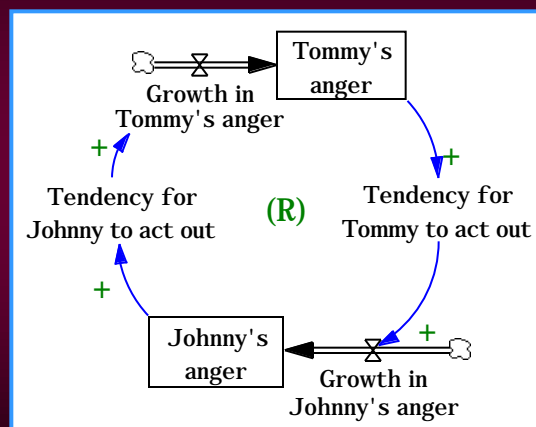
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Event thinking =>

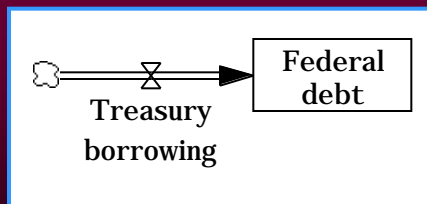
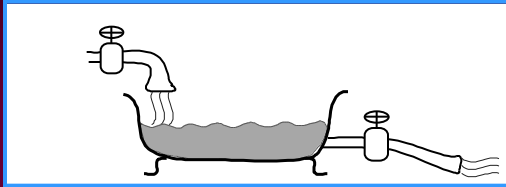


<= Dynamic thinking

A Stock-and-Flow/Feedback View



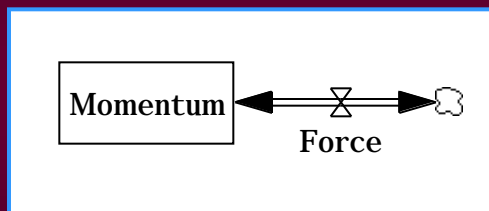
Stocks and Flows



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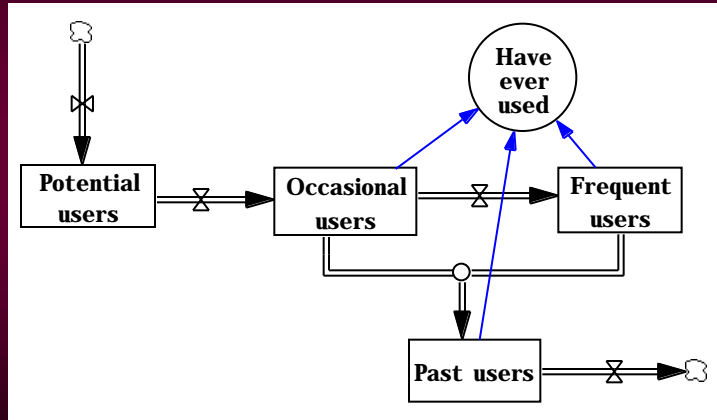
Newton's Stock-and-Flow Insight



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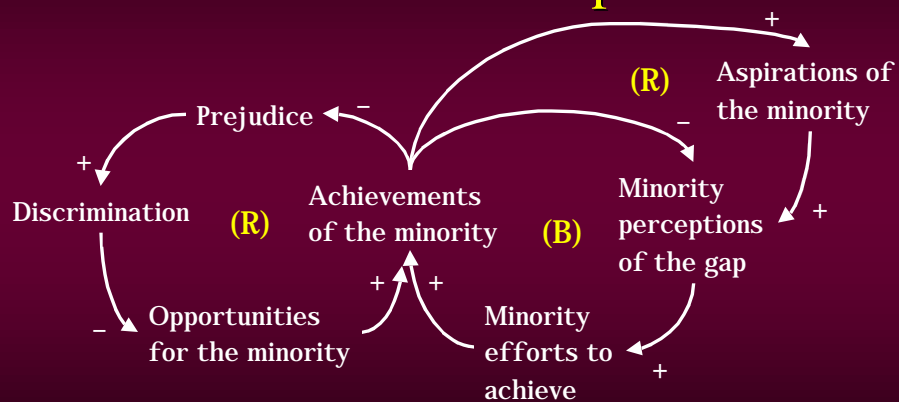
A Drug Researcher's Stock-and-Flow Insight



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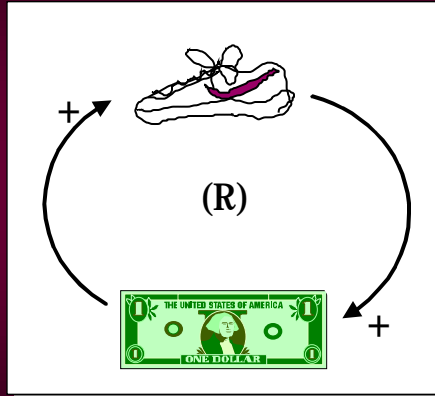
Reinforcing and Balancing Feedback Loops



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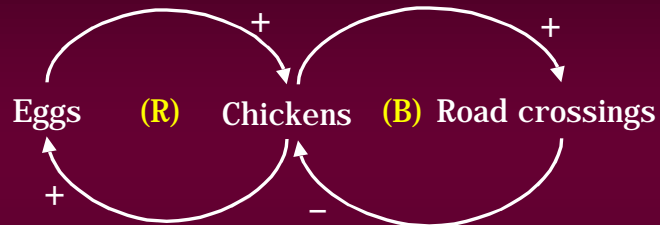
A First-Grader's Feedback Insight



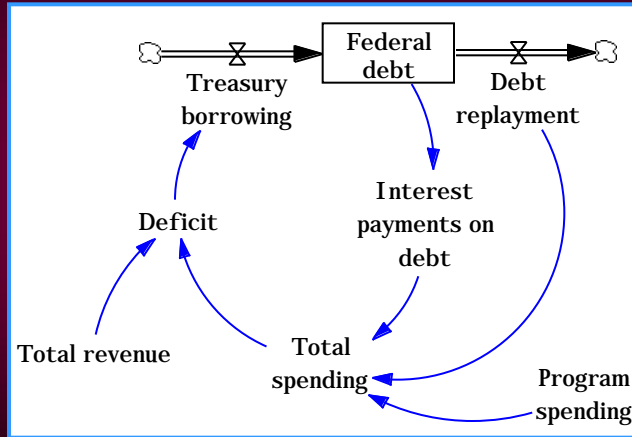
The more shoes
Nike makes, the
more money they
make,

so the more
shoes they can
make.

An MIT Professor's Feedback Insight



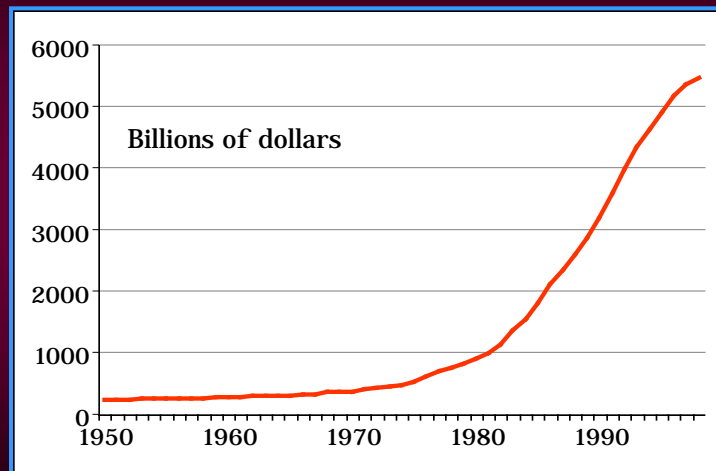
Deficit and Debt



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U.S. Federal Debt



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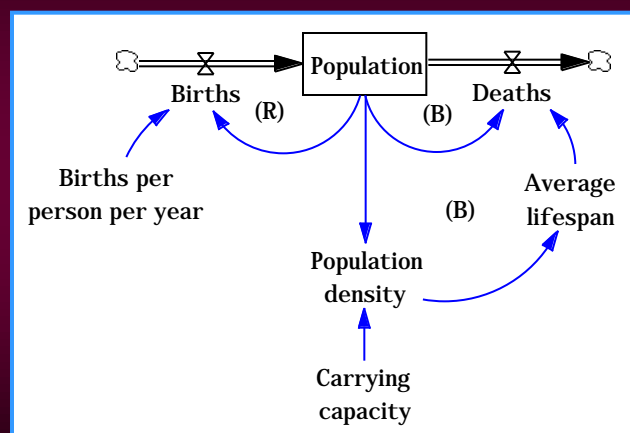
Insights from Deficit and Debt

- 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.

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The Message of Malthus



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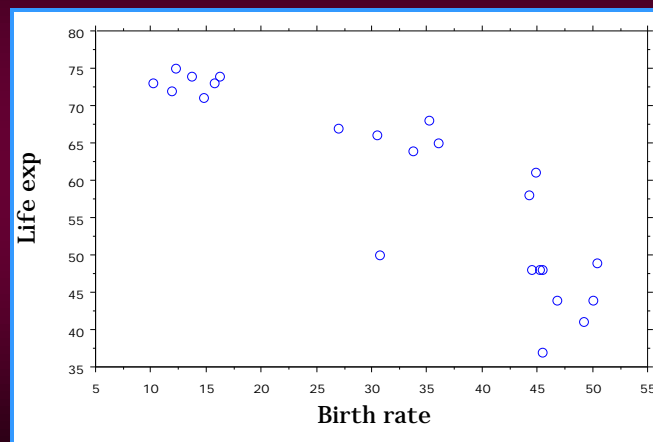
Malthusian Insights

- “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.

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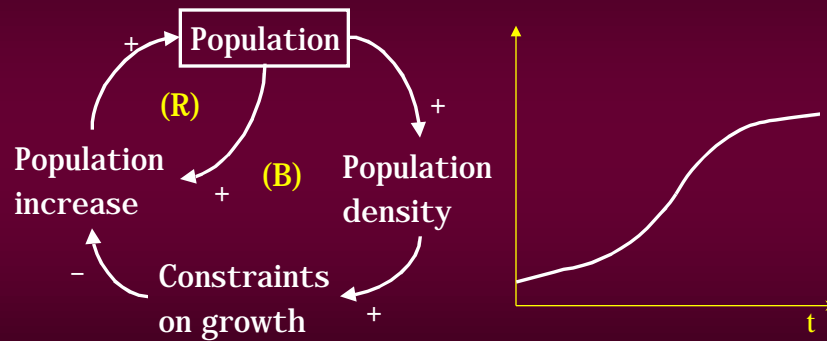
Life Expectancy vs Birth Rate in 23 Countries



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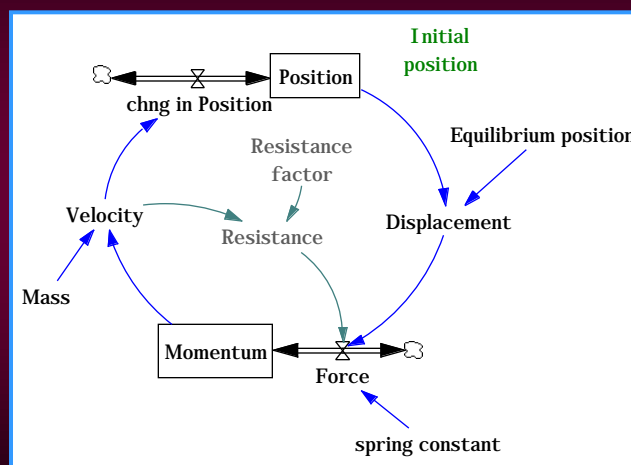
“Shifting Loop Dominance” Insight



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An Oscillating Spring



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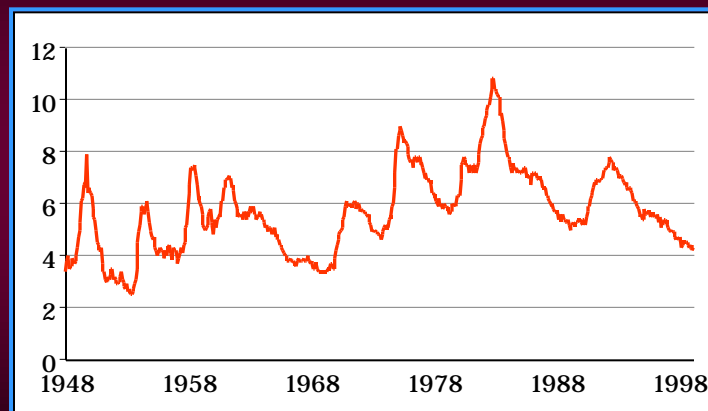
Insights from an Oscillating Spring

- 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.

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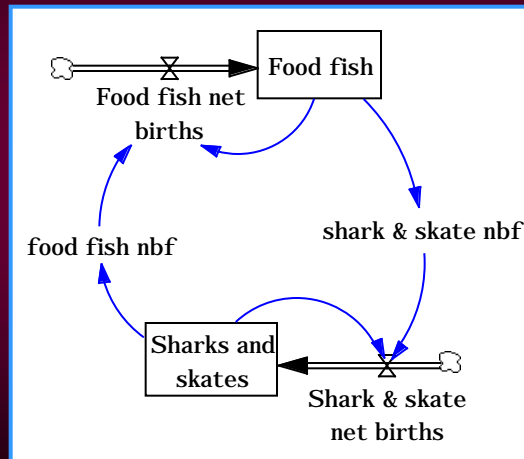
U.S. Unemployment Rate



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Predator/Prey Oscillations and Volterra's Principle



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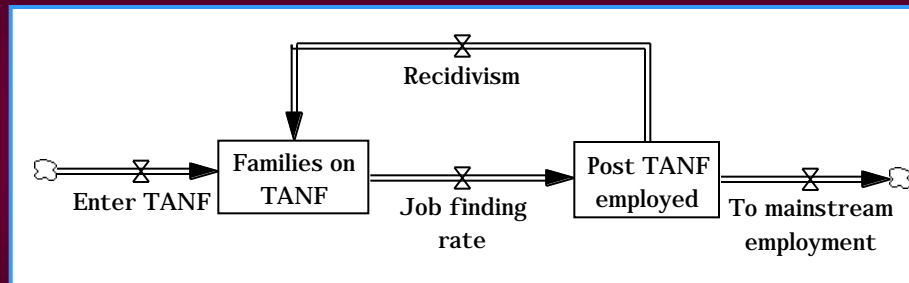
Volterra's Insight

- 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.

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A Social Welfare Archetype



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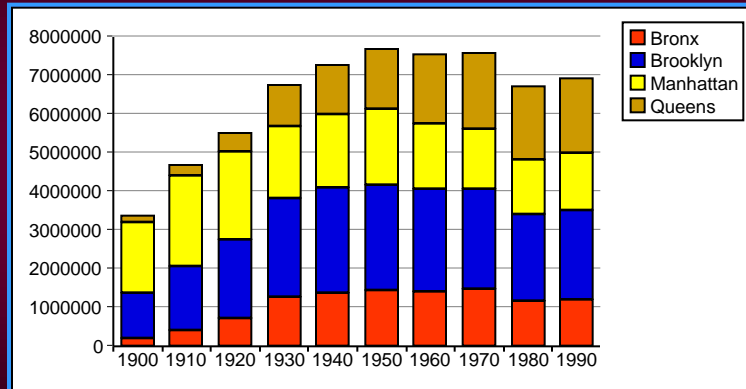
Insights from the Archetype

- 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.

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New York City Population



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Insights from URBAN1

- Cities grow into a fierce competition for scarce 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.

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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)

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But I must admit...



...this guy is a cuter little model.

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...but not as insightful.

**Great thinkers are feedback thinkers;
Great thoughts are feedback thoughts**

“But the crucial point is this: an order imposed on people purely from outside themselves ... destroys all faith in the possibility of order. ...So it turns into a vicious circle. Society alienates people while at the same time summoning them to cooperate in the work of their own alienation. They rebel. The machinery of alienation is then tightened up, and social control becomes more and more arbitrary. The result is a more widespread and furious rebellion....” (Thomas Merton 1965)