NAVAL
POSTGRADUATE
SCHOOL

System Dynamics Behaviors for Modeling Lawmaking Processes

Ray Madachy
Naval Postgraduate School
rjmadach@nps.edu

4th Annual Science of Laws Conference
December 2, 2017

Monterey, California
WWW.NPS.EDU

Outline

- Introduction and Background
- Review of Model Elements and Structures
- Causal Loop Diagrams
- Structure – Behavior Pairs
- System Archetypes
- Conclusions and Future Work
- References
- Backups

Introduction and Background

- Modeling and simulation can help improve the efficiency of lawmaking processes, and the effectiveness of laws created.
- System dynamics is a simulation methodology for modeling continuous systems that provides a rich and integrative framework for investigating lawmaking process phenomena and inter-relationships from a holistic perspective.
- This work applies simulation concepts defining model structures and associated behaviors that can be used to
  - Evaluate the lawmaking process, i.e. the related activities undertaken to create laws.
  - Assess laws before implementation on how well they will meet their goals and compare options. This includes all intended and unintended consequences of law implementation.
  - Gain lessons learned from past lawmaking experiences.
- It organizes system dynamics model structures and behaviors for lawmaking processes starting with elemental components, incorporating them into basic flow structures and building up to larger infrastructures.
  - The recurring structures are model "building blocks" that can be reused with their pattern behaviors.

New Aspects

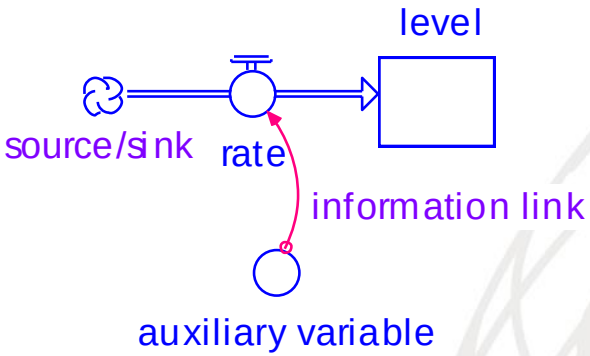
- Previous work focused on defining system dynamics model structures, interpreting them for lawmaking processes, and trial modeling.
- This continues by elaborating the behaviors associated with the generic structures, and demonstrating with examples.
  - Introduces related systems thinking tool of causal loop diagramming
  - Highlights important structure-behavior pairs found in systems
  - Explains system archetypes, identifies lawmaking examples and provides beginning illustrative models.

System Dynamics Principles

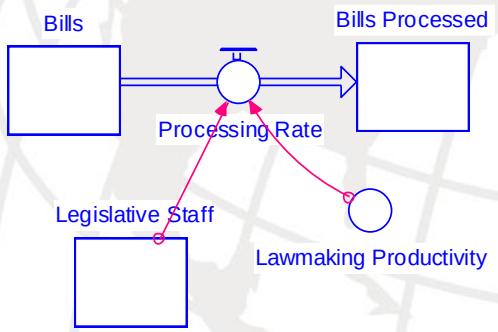
- Major concepts
  - Defining problems dynamically, in terms of graphs over time
  - Striving for an endogenous, behavioral view of the significant dynamics of a system
  - Thinking of all real systems concepts as continuous quantities interconnected in information feedback loops and circular causality
  - Identifying independent levels in the system and their inflow and outflow rates
  - Formulating a model capable of reproducing the dynamic problem of concern by itself
  - Deriving understandings and applicable policy insights from the resulting model
  - Implementing changes resulting from model-based understandings and insights.
- Dynamic behavior is a consequence of system structure
- The continuous view
  - Individual events are not tracked
  - Entities are treated as aggregate quantities that flow through a system, and can be described through differential equations
  - Discrete approaches usually lack feedback, internal dynamics

System Dynamics Notation

- *System represented by x'(t)= f(x,p).*
  - *x: vector of levels (state variables), p: set of parameters*
- *Legend:*



- *Example system:*



Outline

- Introduction and Background
- Review of Model Elements and Structures
- Causal Loop Diagrams
- Structure – Behavior Pairs
- System Archetypes
- Conclusions and Future Work
- References
- Backups

Terminology

- ***Elements*** are the smallest individual pieces in a system dynamics model: levels, rates, sources/sinks, auxiliaries and feedback connections.
- ***Generic flow processes*** are small microstructures and their variations comprised of a few elements, and are sometimes called *modeling molecules*. They are the building blocks, or substructures from which larger structures are created and usually contain approximately 2-5 elements.
- ***Infrastructures*** refer to larger structures that are composed of several microstructures, typically producing more complex behaviors.
- ***Flow chains*** are infrastructures consisting of a sequence of levels and rates (stocks and flows) that often form a backbone of a model portion. They house the process entities that flow and accumulate over time, and have information connections to other model components through the rates.

Elements

- **Levels** are the state variables representing system accumulations. Their counts can be measured in a real system at a snapshot of time (e.g. the number of current laws on the books). Typical state variables are laws or rights, violations, lawsuits, or the numbers of people involved in legal systems.
- **Sources and sinks** represent levels or accumulations outside the boundary of the modeled system. Sources are infinite supplies of entities and sinks are repositories for entities leaving the model boundary. Typical examples for lawmaking sources could be needs for new regulations originating in society or business at-large, or the generation of court filings to be handled. Sinks could represent final judgments of cases leaving court dockets or legal personnel attrition repositories for retirees.

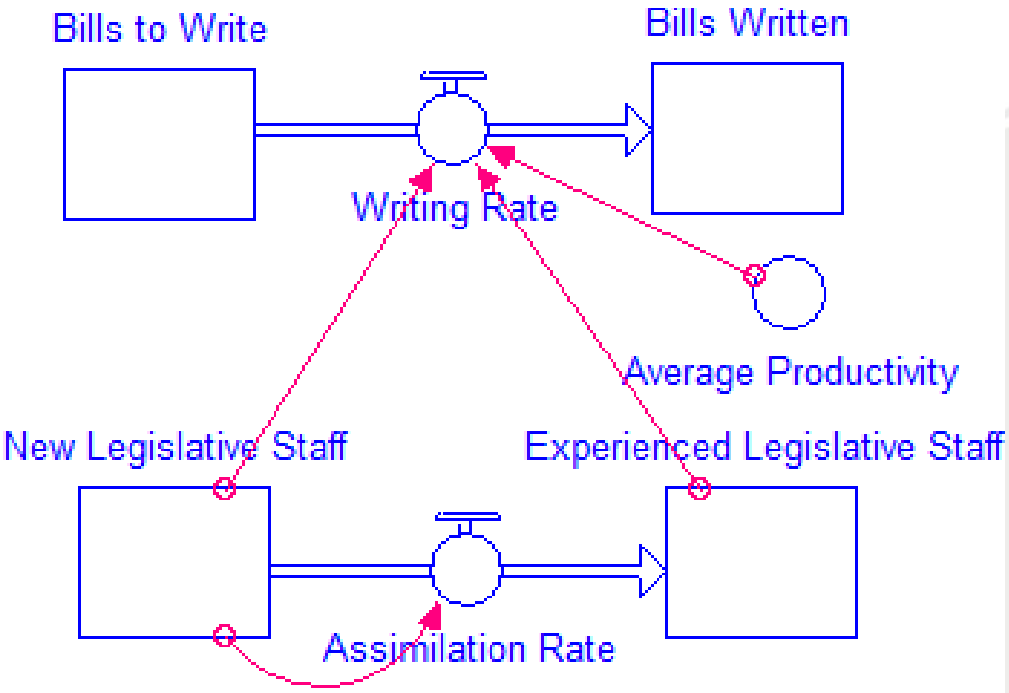
Elements (Continued)

- **Rates** in the lawmaking process are necessarily tied to the levels. Levels don't change without flow rates associated with them. Some examples include law-writing rates, law change rates, case turnover rates, infraction rates, personnel hiring and retiring rates.
- **Auxiliaries** often represent "score-keeping" variables. Example for tracking purposes include the percent of infractions per population level, percent of injuries or deaths per population, case progress measures, percent of cases in legal states, other ratios or percentages used as independent variables in dynamic relationships.

Major Level Types for Lawmaking

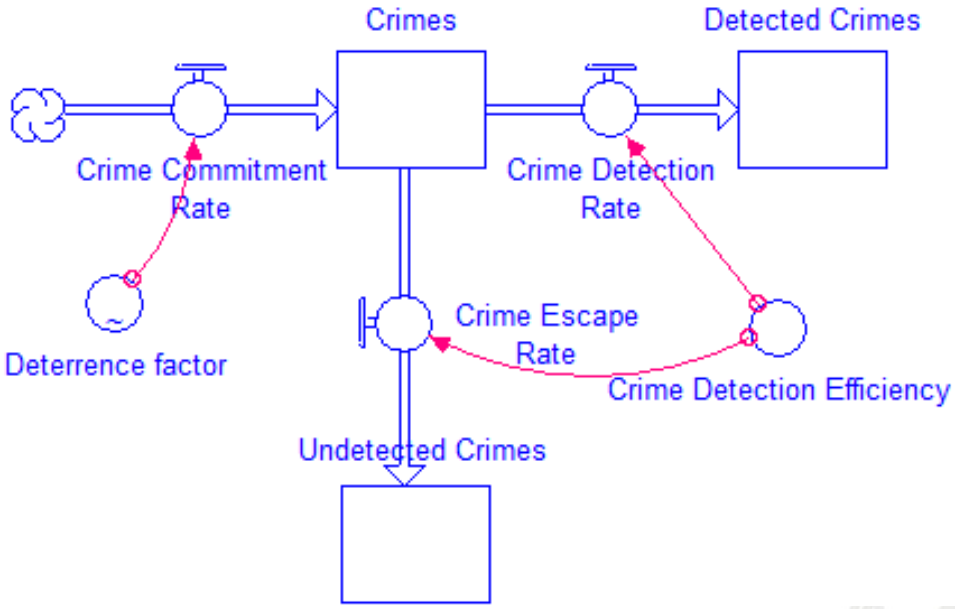
- **Laws or Rights** – These may include laws (e.g. statutes, ordinances, regulations, common laws); copyrights or intellectual property rights for any jurisdiction, etc. Laws can be represented at any stage in the lawmaking process from proposed bills to amended or repealed laws, and for any level of jurisdiction. Rights levels can be in different process stages from initial filing to infringement.
- **Violations** – Law violations cover crimes or infractions at any jurisdiction level (international, national, local) including copyright or intellectual property right infringements. These may lead to criminal cases potentially resulting in jail and/or fines levied, or civil lawsuits potentially resulting in damages to pay.
- **People** – People levels represent pools of individuals performing legal-related functions including their sub-divisions such as law creation by elected or appointed officials, legislative staff support, legal enforcement, and judicial personnel; people affected by laws such as overall population levels, victims, incarcerated prisoners, family dependents of incarcerated people, and others.

Example Production Infrastructure



Writing rate productivity adjusted for experience levels

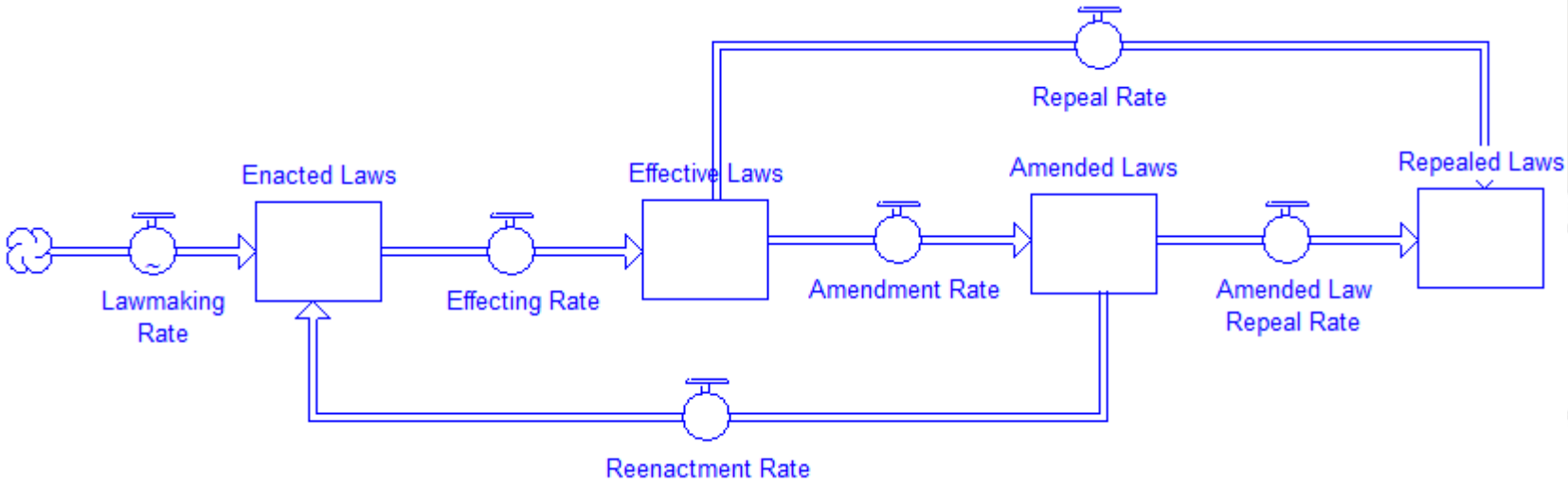
Example Crime Detection Structure



- Multiple level flow chain for crimes
- Split flow process

Crime Commitment Rate = Graph(Deterrence Factor)
Crime Detection Rate = Crime Detection Efficiency * Crime Commitment Rate
Crime Escape Rate = (1 - Crime Detection Efficiency) * Crime Commitment Rate

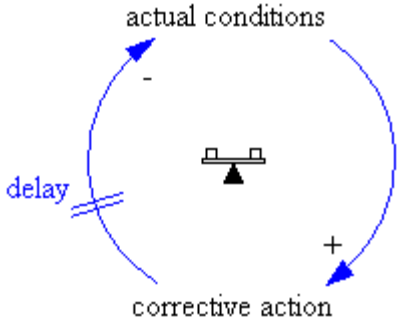
Example Lawmaking Process Flow Chain

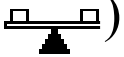


Outline

- Introduction and Background
- Review of Model Elements and Structures
- Causal Loop Diagrams
- Structure – Behavior Pairs
- System Archetypes
- Conclusions and Future Work
- References
- Backups

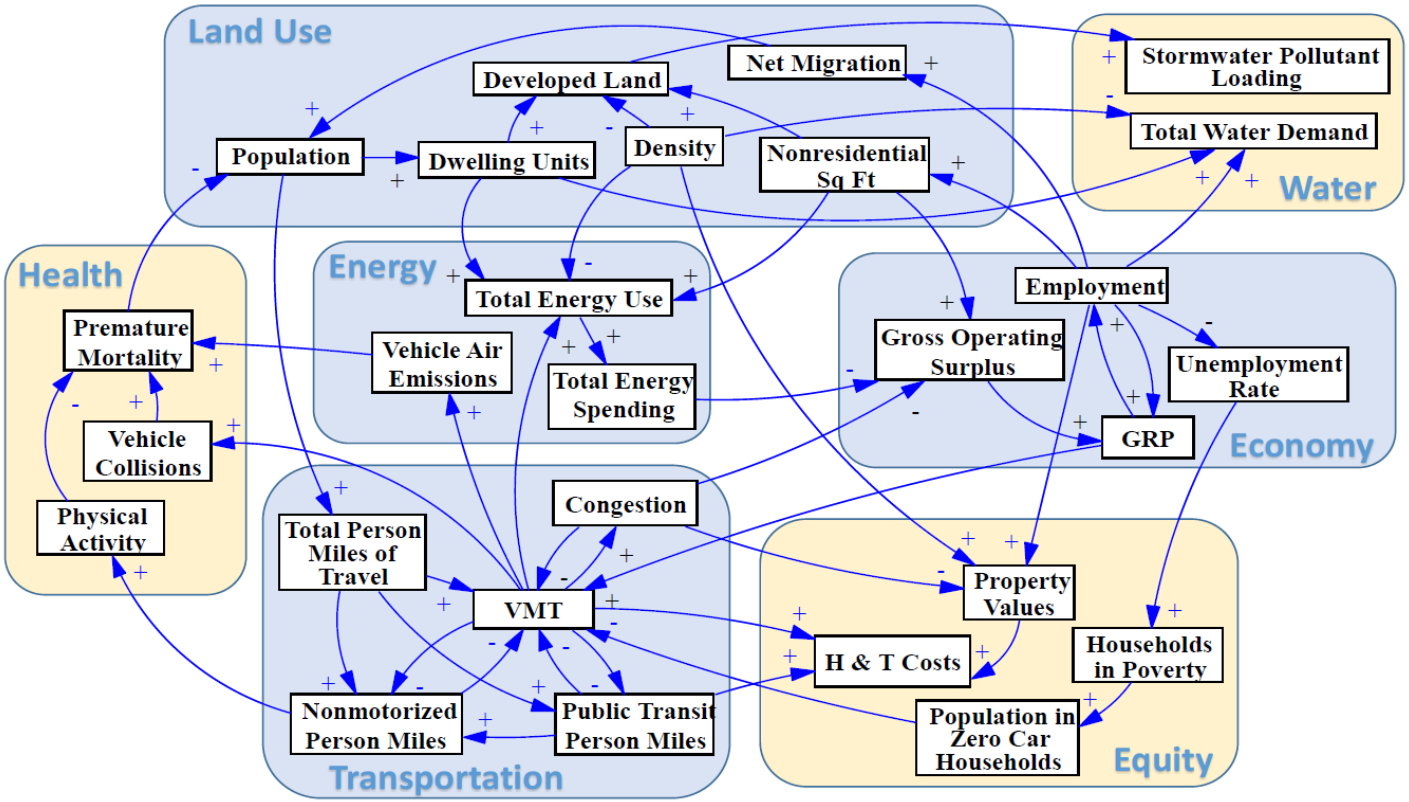
Causal Loop Diagrams



- Simple diagrams that help portray cause and effect relationships and information feedback in a system. A loop is a closed chain of cause and effect.
  - Can be very effective in explaining how dynamic behavior patterns are generated and remedied.
- They show variables connected by causal links (⟶), delays (||) and connection polarities (+, -). Positive and negative feedback loops describe the circles of cause and effect.
  - A positive causal link (+) means the two nodes change in the same direction, and a negative causal link (-) means they change in opposite directions.
- A closed cycle is either defined as a reinforcing () or balancing () feedback loop.
  - Trace the direction of change around each loop in the diagram. If, after cycling around the loop, the direction of change of the starting point variable is in the same direction as its initial change it is a positive (reinforcing) feedback loop. If the direction of change is opposite to its initial direction it is a negative (balancing) loop.

Example Regulatory Causal Loop Diagram

- Causal loop diagram for extensive system dynamics model evaluating light rail project in North Carolina (Environmental Protection Agency, 2016)



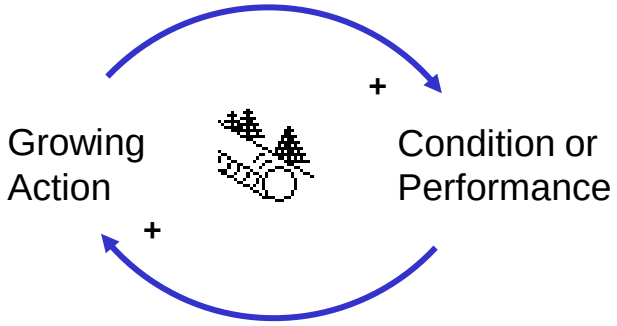
Outline

- Introduction and Background
- Review of Model Elements and Structures
- Causal Loop Diagrams
- Structure – Behavior Pairs
- System Archetypes
- Conclusions and Future Work
- References
- Backups

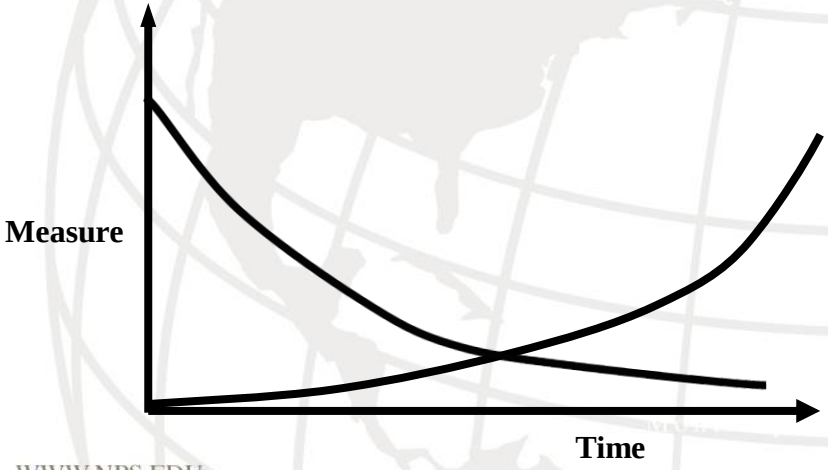
Exponential Growth/Decay

- Growth structures are based on the generic compounding flow process.
- Decay structures are similar but a draining flow process whereby the outflow rate decreases with the level.
- Lawmaking examples
  - Escalation in number of laws, legal paperwork levels, escalation of new crime markets (until balancing limits are reached)

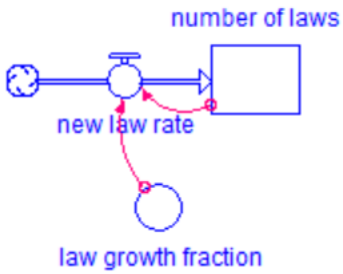
Structure

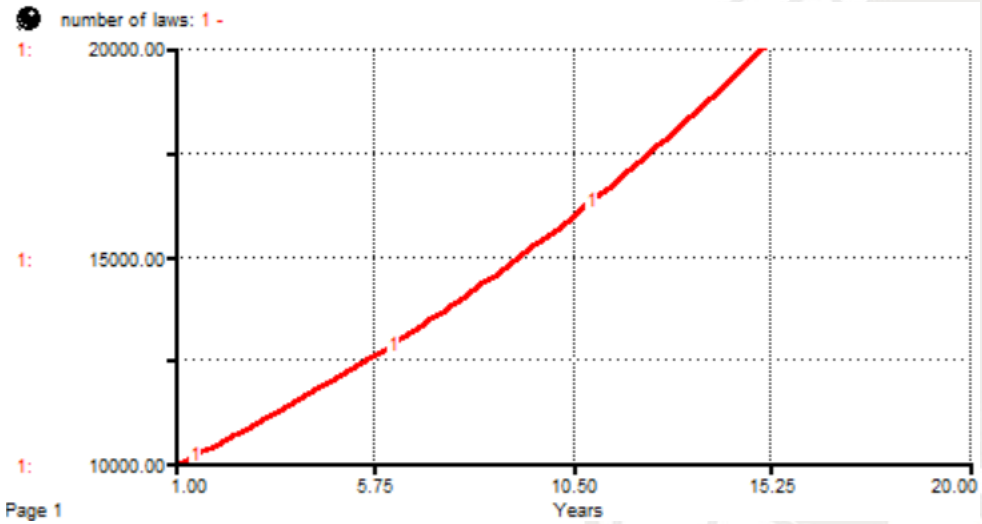


Behavior



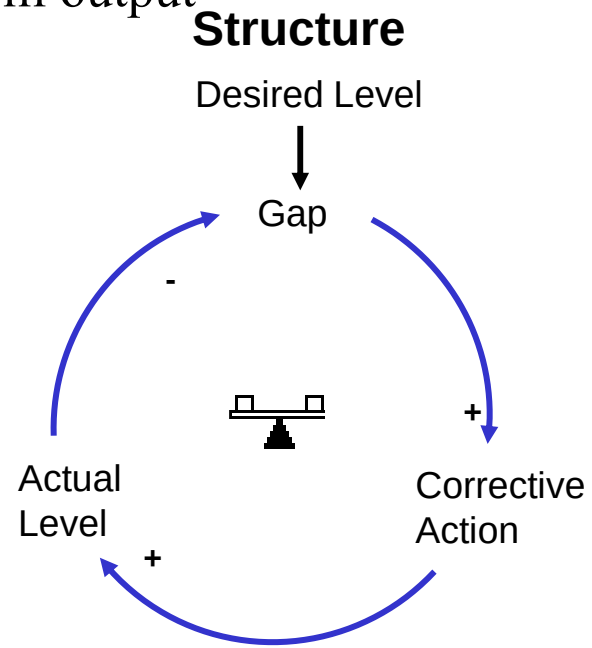
Example Exponential Growth

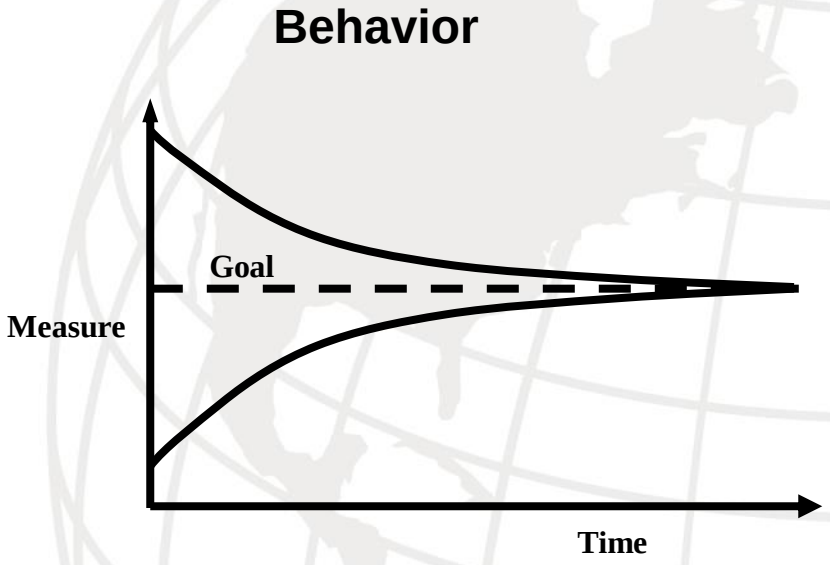




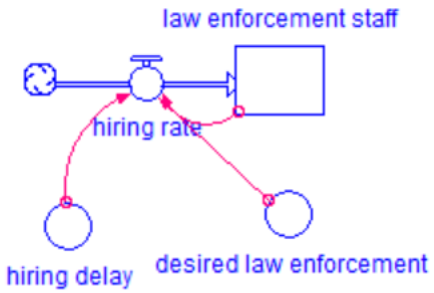
Goal Seeking Behavior

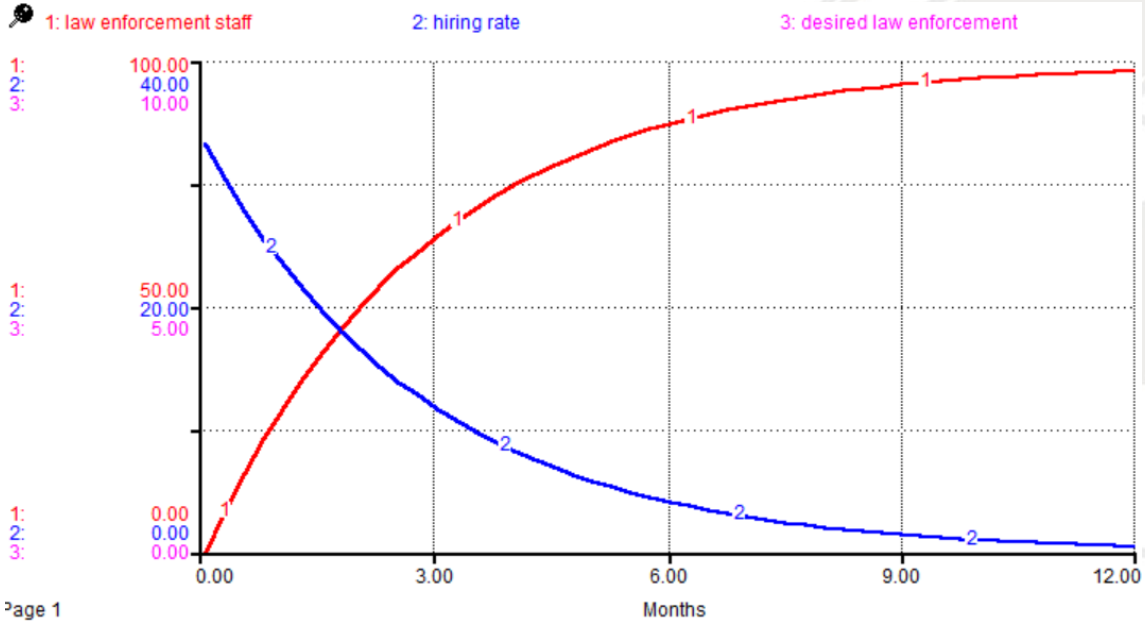
- A balancing process seeking to close the gap between a goal and actual conditions.
- Example lawmaking goals may include desired revenue from taxes or other means, reduced crime levels, minimizing deaths and accidents via regulation (driving, drug laws), public construction, welfare or health care coverage, preservation of natural resources, legal-related resource needs, bill output





Example Goal Seeking Behavior with Balancing Feedback



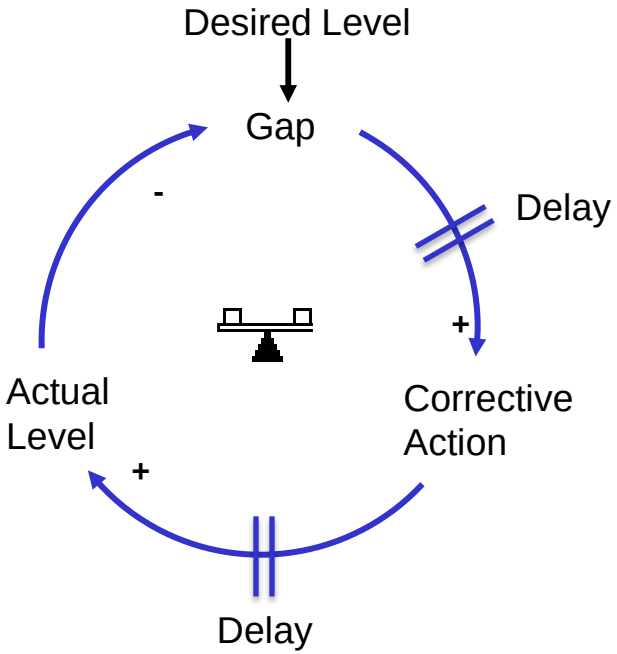


hiring rate = (desired law enforcement – law enforcement staff) / hiring delay

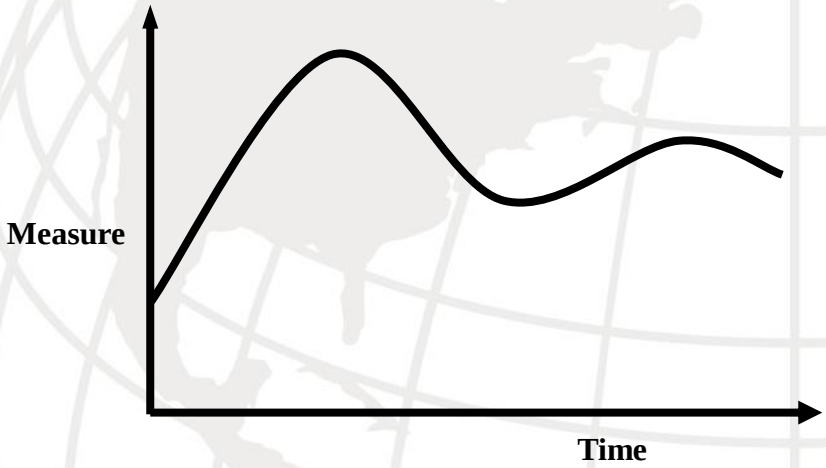
Oscillation

- Oscillation is caused by a balancing process with large time delays, creating under and over adjustments around the goal.
  - More than one level must be in system to cause oscillation.
  - Often there is a target goal that the system is trying to reach, and the system is unstable as it tries to attain the goal.
- Lawmaking examples are oscillating crime rates, levels of law enforcement (event-driven over adjustments, panic reactions), short term transient fixes

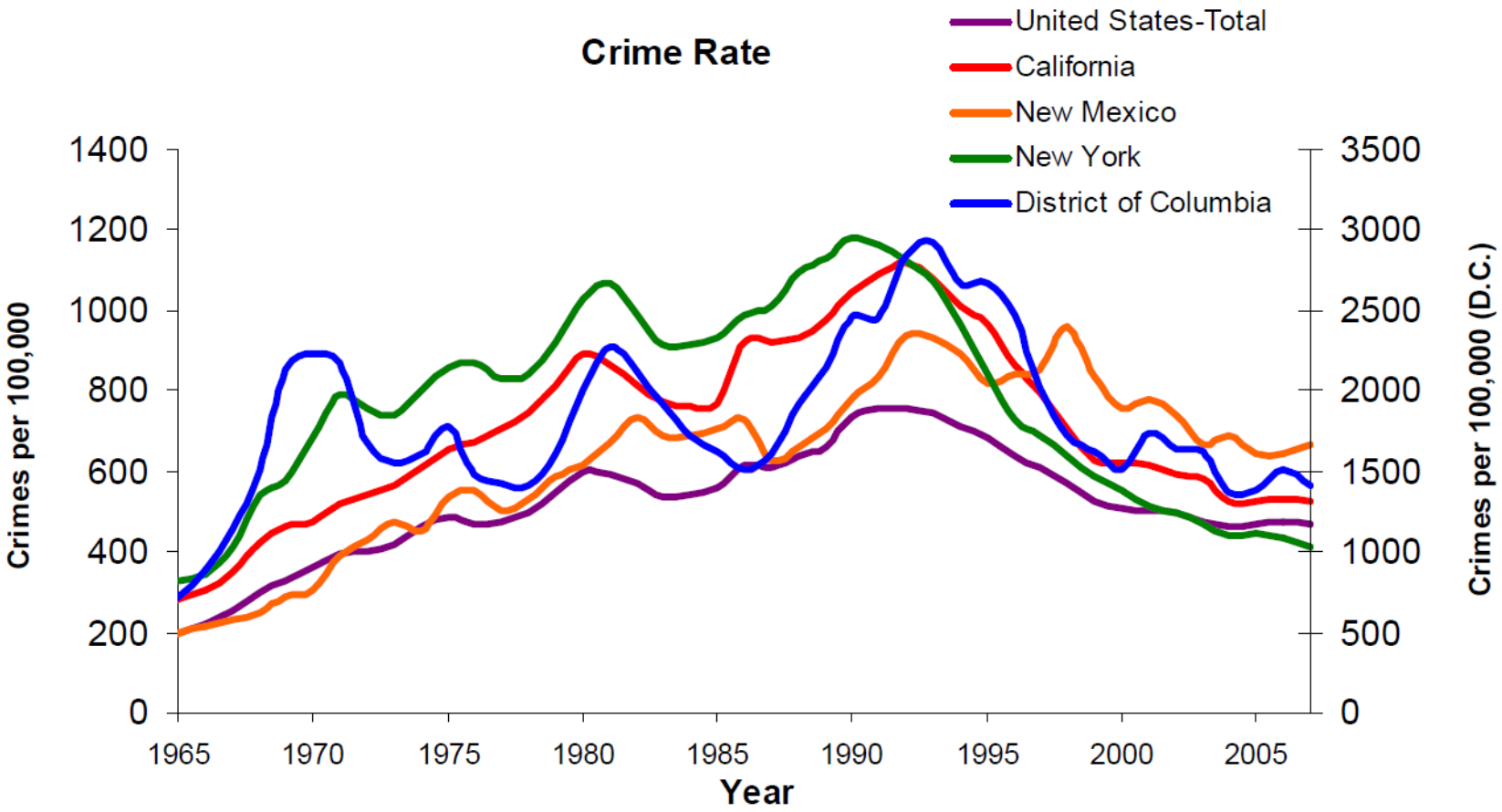
Structure



Behavior



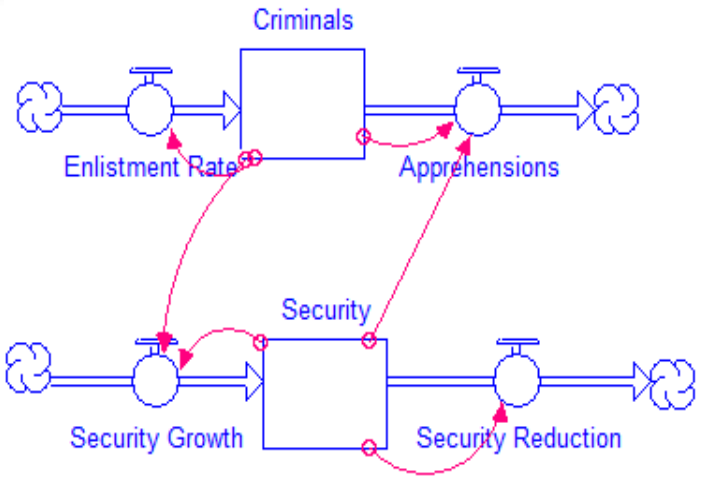
Actual Oscillation Behavior

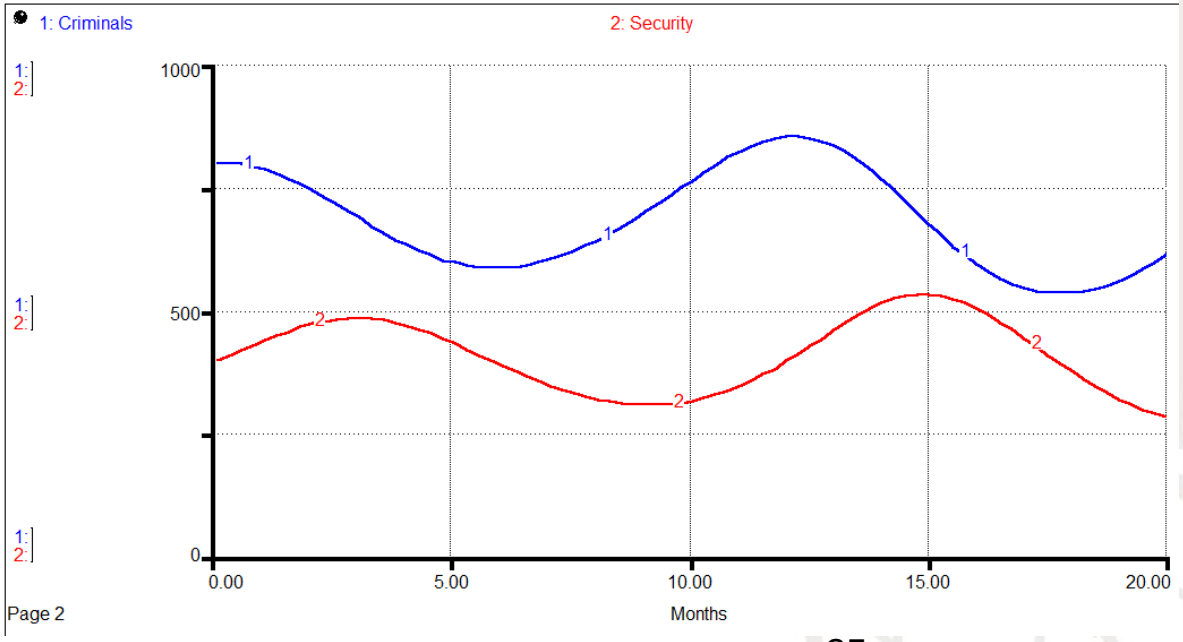


- Bureau of Justice Statistics (2008)

Example Oscillating Behavior

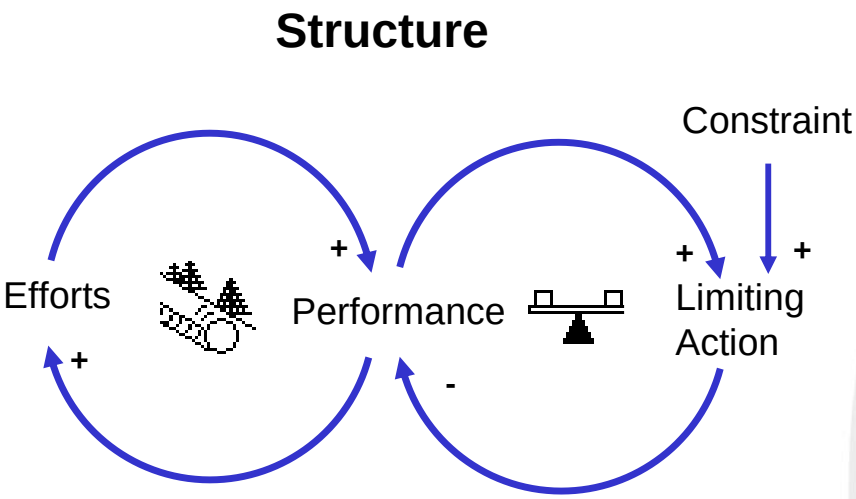
- Continuous forces in region as Predator-Prey model.

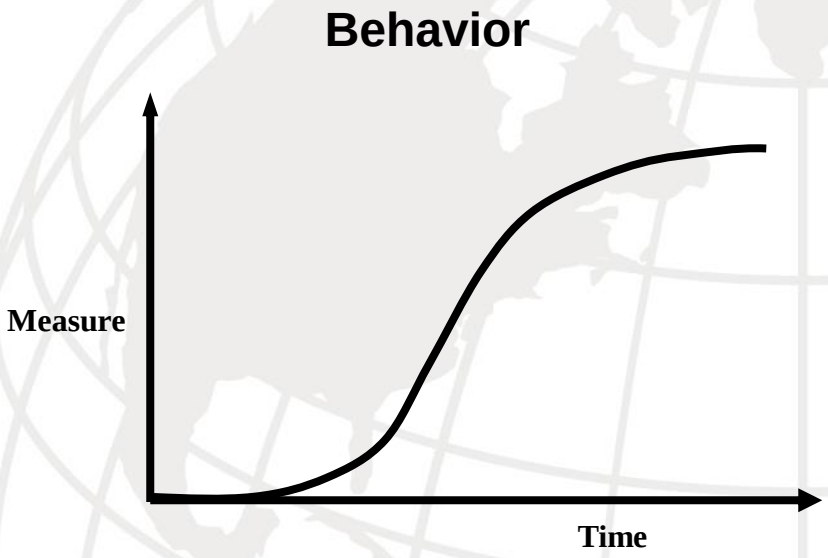




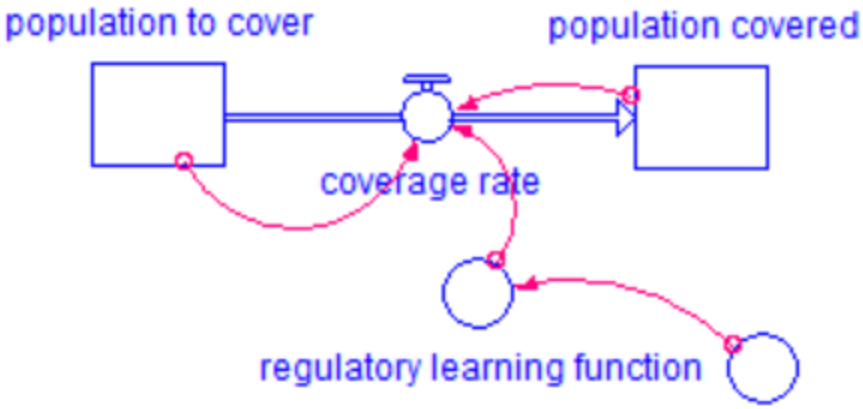
S-Shaped Growth

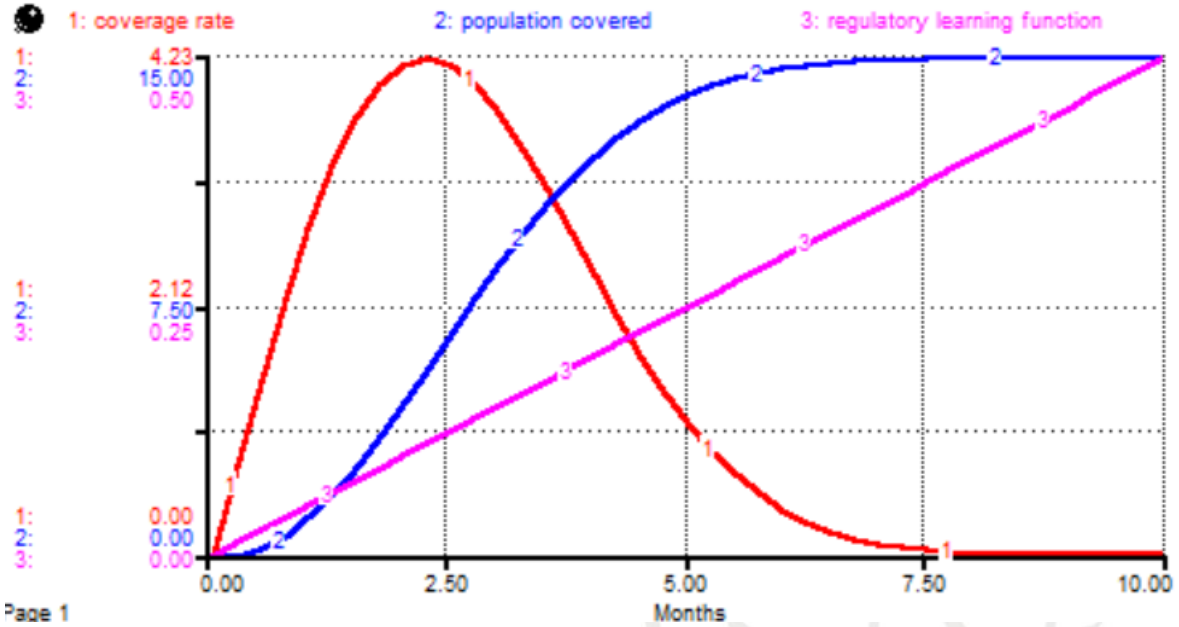
- S-shaped growth is the result of a reinforcing process that becomes stalled by a balancing process.
- Lawmaking examples are cumulative progress/cost to establish new laws, knowledge diffusion of regulations or enforcement, law adoption, population coverage over time





Example S-Shaped Growth





Outline

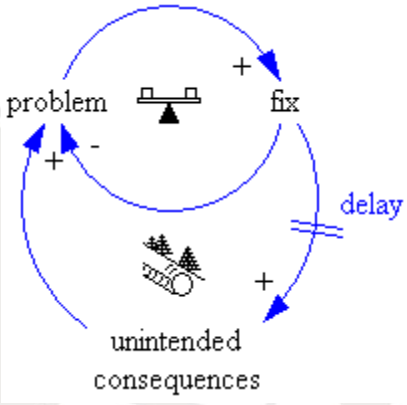
- Introduction and Background
- Review of Model Elements and Structures
- Causal Loop Diagrams
- Structure – Behavior Pairs
- System Archetypes
- Conclusions and Future Work
- References
- Backups

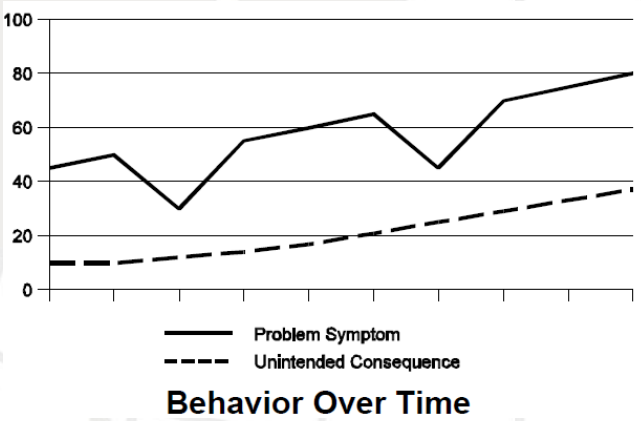
System Archetypes

- System archetypes present lessons learned from systems with specific structures that produces characteristic modes of behavior, or patterns. They interpret the generic structures to provide better understanding and insight.
  - Often illustrated with simple causal loop diagrams
- The archetypes explain and make visible the recurring stories that happen in many areas of society. The archetypes let us step back to understand systemic challenges, and help design plans to address them.
- They can help us grasp the complexities of laws and to address the stubborn, recurring problems that confront us in a society governed by laws.
  - Typical lawmaking examples show how unintended consequences of laws occur.

Fixes That Fail

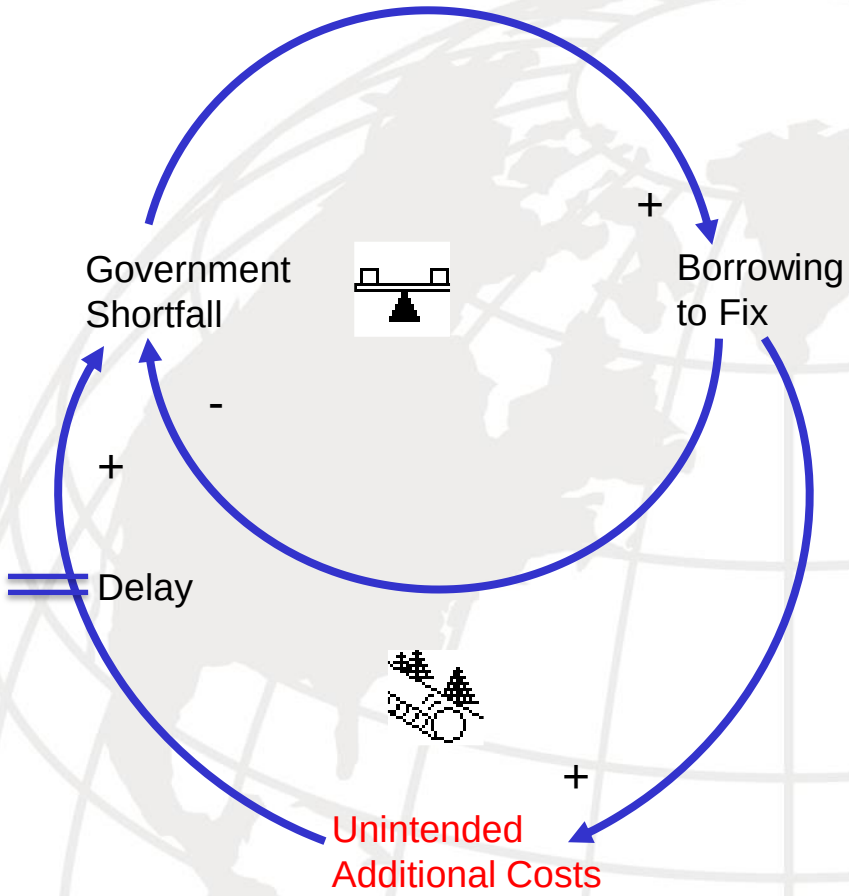
- Efforts to bring something into balance create consequences that reinforce the need to take more action.
- A short-term fix creates side effects for the long-term, and often results in more fixes needed.
- Lawmaking examples
  - Government increasing the cigarette tax to raise more taxes causes smuggling of cigarettes, thus reducing the number of taxed cigarettes sold
  - Drug war enforcement raises price of illicit drugs, thus profiting and further empowering the cartels
  - Endangered species act causes landowners to kill such animals on property in order to sell to developers
  - "Three strikes and you're out" law gave incentive to evade 3rd arrest, leading to more violent crime on police



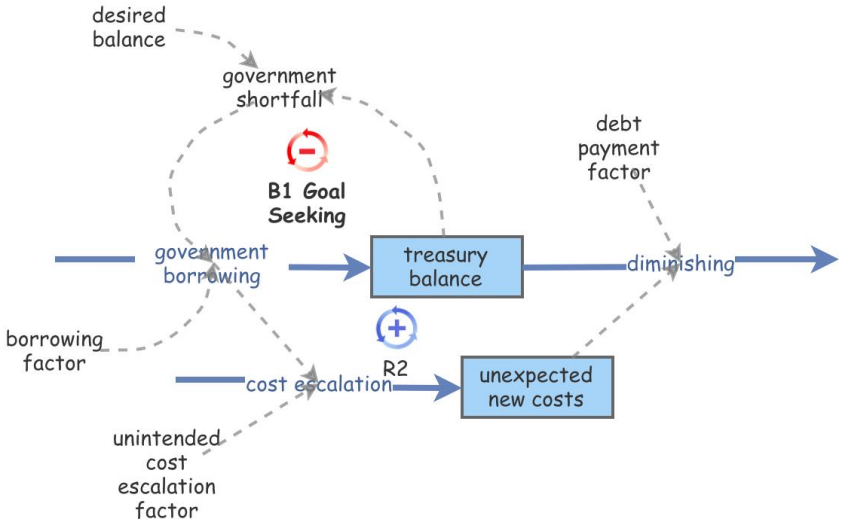


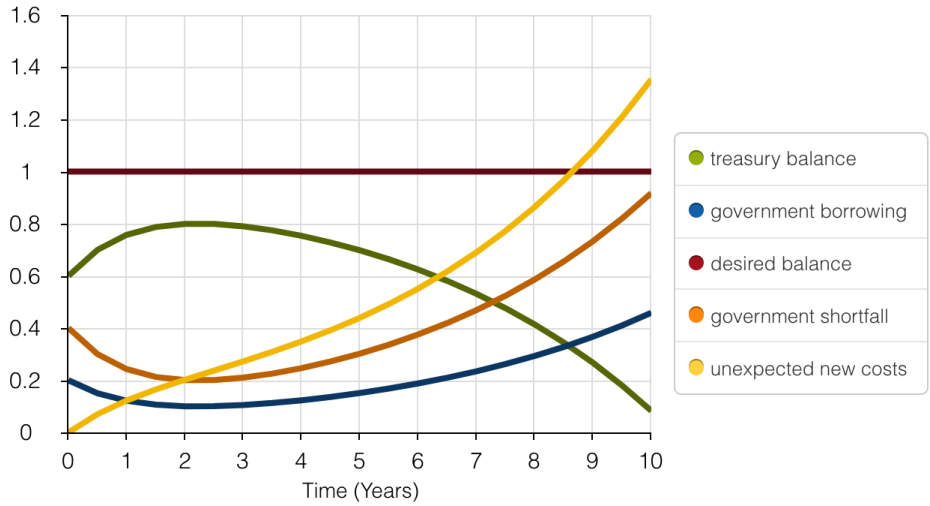
Example Lawmaking Fixes that Fail

- Elected lawmakers are faced with spending programs that exceed national or state revenues. They cover the shortfall by borrowing money to finance roads, defense, medical assistance, welfare, and other programs and services.
- The following year, these expenditures include continuation and maintenance of existing projects, new promises to constituents, and payments on the earlier debt.
- Faced with the painful and unpopular choices of cutting programs or raising taxes, they take the easy way out and borrow again.
- Government gets saddled with increasing debt, and interest payments on that debt becoming a larger portion of the budget.



Lawmaking Fixes That Fail Model

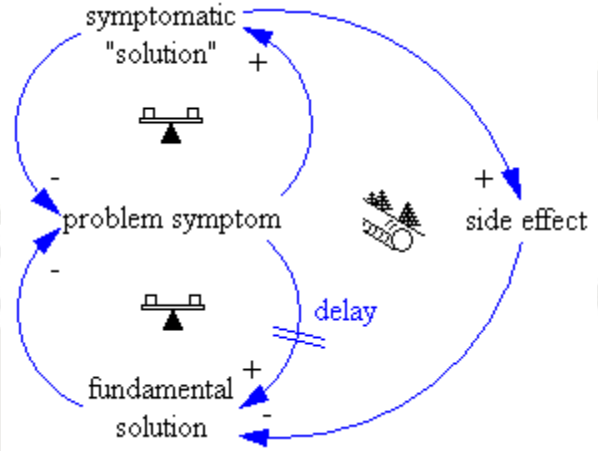


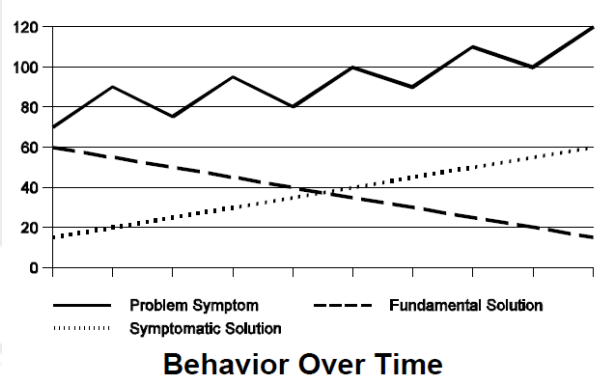


- Short term improvement gets overwhelmed by long term new debt costs
- Run or clone model at https://insightmaker.com/insight/93082/Lawmaking-Fixes-that-Fail

Shifting the Burden

- Two balancing loops compete for control in "solving" a problem symptom, while a reinforcing side-effect of one solution makes the problem worse.
- When a symptomatic solution is implemented, the symptom is reduced which lessens the pressure for implementing a more fundamental solution. Over time, the symptom resurfaces, and another round of symptomatic solutions is implemented. Side-effects further divert attention away from more fundamental solutions.
- Lawmaking examples
  - Inadequate regulations and drug company behavior shifting the high cost of drugs to consumers
  - Bank failures addressed symptomatically by creating FDIC and FSLIC, not a fundamental solution of prudent banking practices. Responsibility for protecting deposits shifted to government.



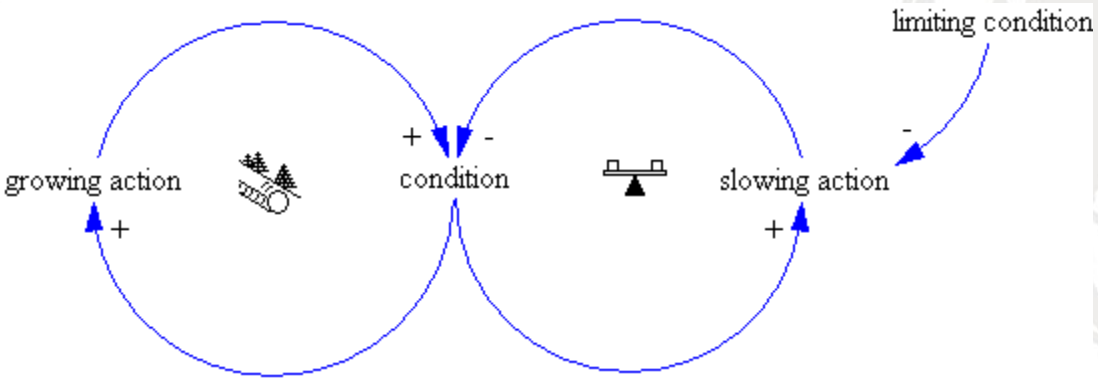


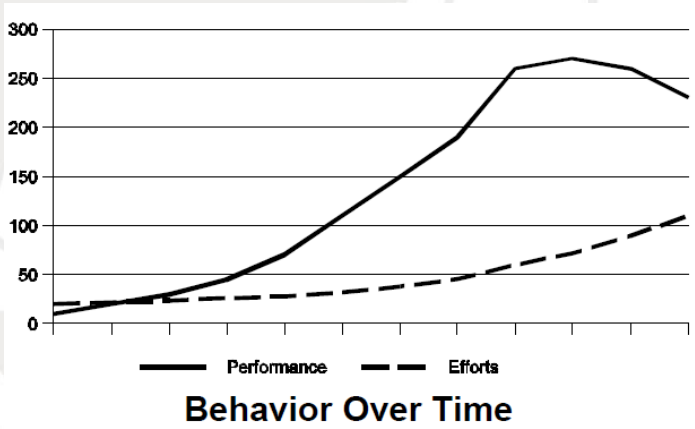
Shifting the Burden Examples (Cont.)

- Government programs often increase the recipient's dependency on the government.
  - Welfare programs that do not attempt to simultaneously address low unemployment or low wages.
  - Drug rehabilitation programs that don't address the root causes of addiction so the patients return.
- These shift the burden back to the intervener, the government.

Limits to Growth

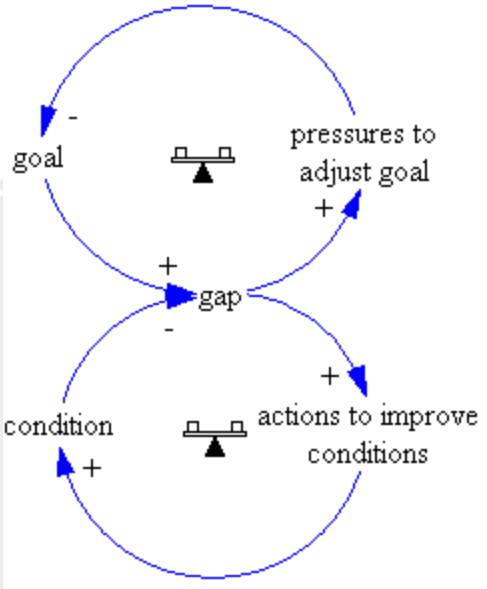
- A reinforcing loop creates pressure in the system that is relieved by one or more balancing loops that slow growth.
- A reinforcing process of growth or expansion will encounter a balancing process as the limit of the system is approached.
- Lawmaking examples
  - Municipal building codes allowing rampant development until no space is left
  - Governments allowing depletion of natural resources eventually stymying industrial growth

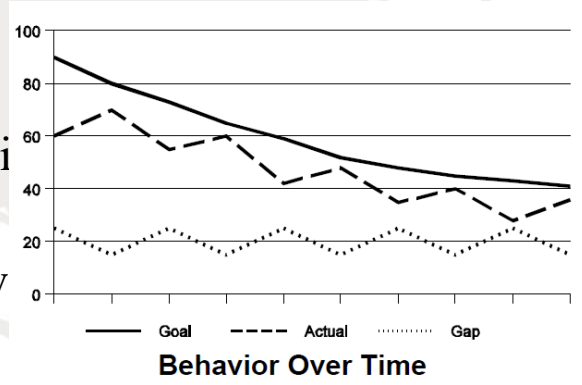




Drifting Goals

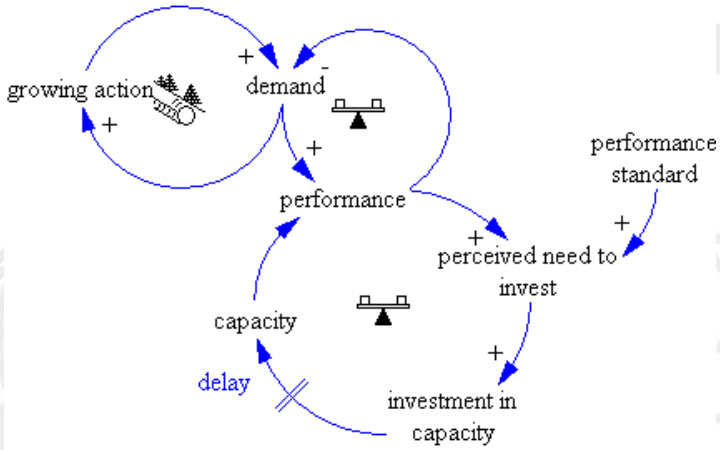
- Two balancing loops strive to close the gap between a goal and current reality.
- When a gap exists, the goal is often lowered to close the gap. Eventually the lowering of the goal leads to deteriorating performance.
  - Similar to shifting the burden, as current problems need to be handled immediately, the long-term goals continuously decline.
- Lawmaking examples
  - Lawmakers allowing public debt increase, sliding limi of environmental pollution.
  - Lawmakers adopting watered down provisions in new bills in order to demonstrate some progress

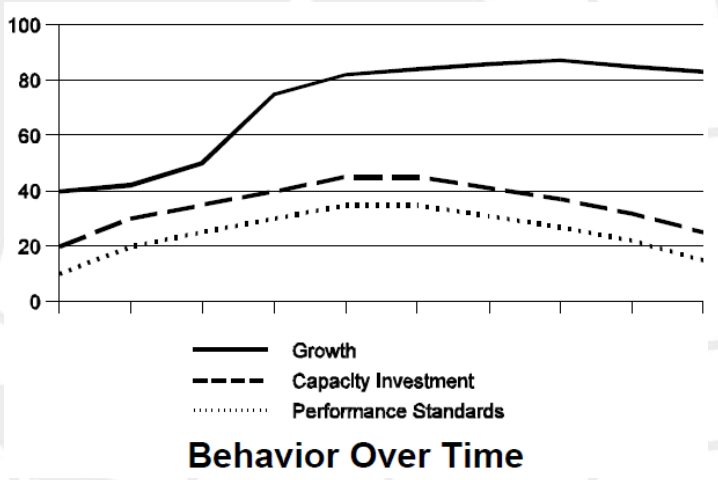




Growth and Under-investment

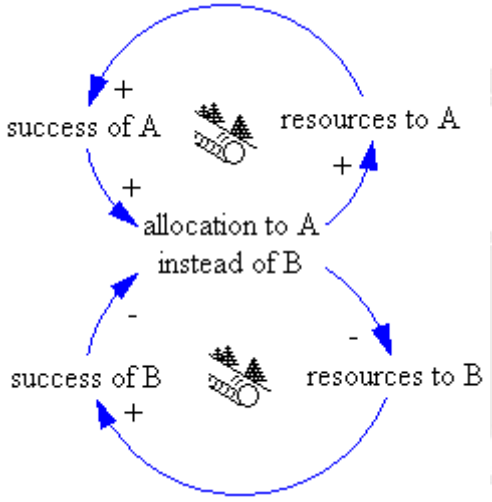
- A "Limits to Growth" structure has an investment-policy balancing loop as a system constraint.
- When growth approaches a limit, the system compensates by lowering performance standards. This reduces perceived need for capacity investments and leads to lower performance, justifying further underinvestment.
- Lawmaking examples
  - Public transportation becoming overcrowded, in need of expansion, but city accepts substandard service and doesn't invest more

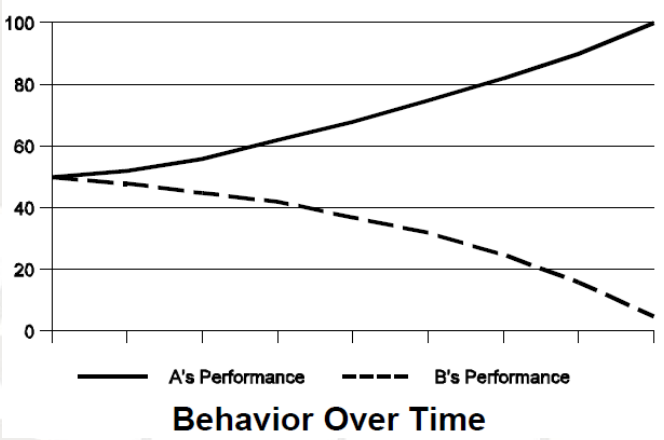




Success to the Successful

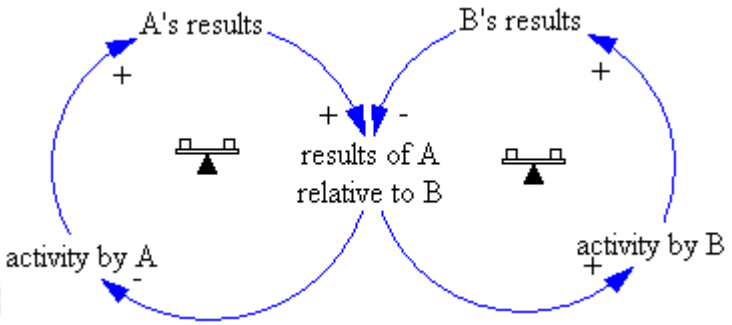
- Two reinforcing loops compete for a common, limited resource.
- In a system with limited resources, one party's initial success justifies devoting more resources to that party, which widens the performance gap between the various parties.
- Lawmaking examples
  - Legislated tax codes: the top 2% continue getting more tax advantages, becoming more influential still
  - International treaty bodies where select countries have more power than others, and use it to maintain advantage over other countries

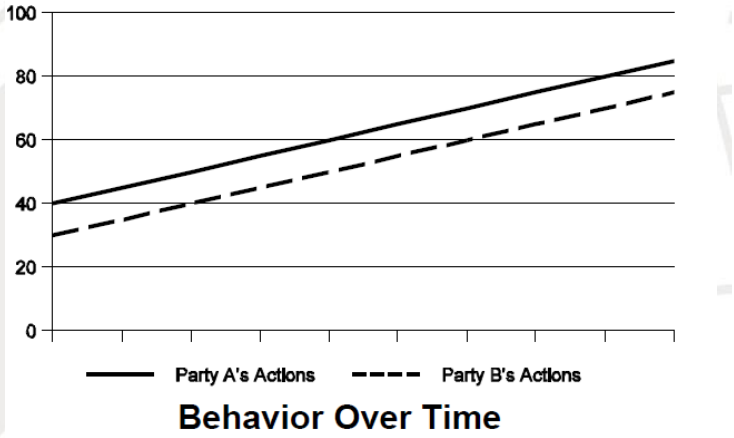




Escalation

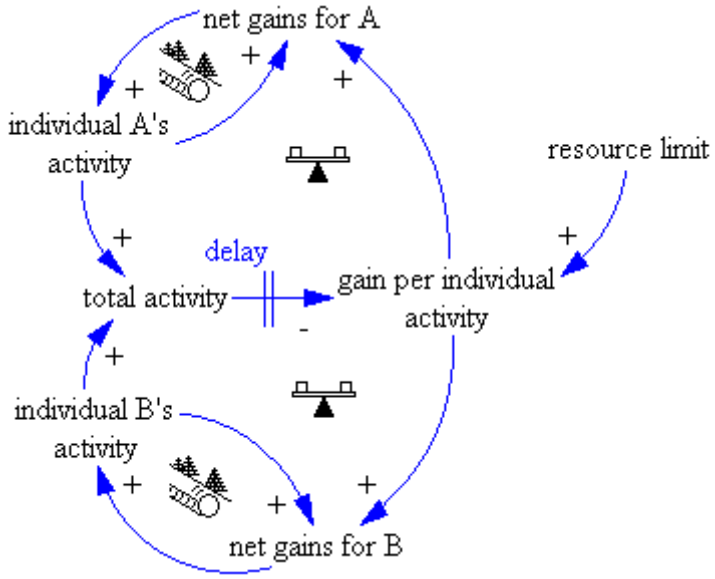
- Two or more players manage their own balancing loop in response to the threatening actions of others.
- A perception of threat causes one party to take actions that are then perceived as threatening by another party. The parties keep trying to outdo one another in a reinforcing spiral of competition.
- Lawmaking examples
  - Legislation supporting war and arms races
  - Legal suits and countersuits
  - Regional escalation of competing security and criminal forces

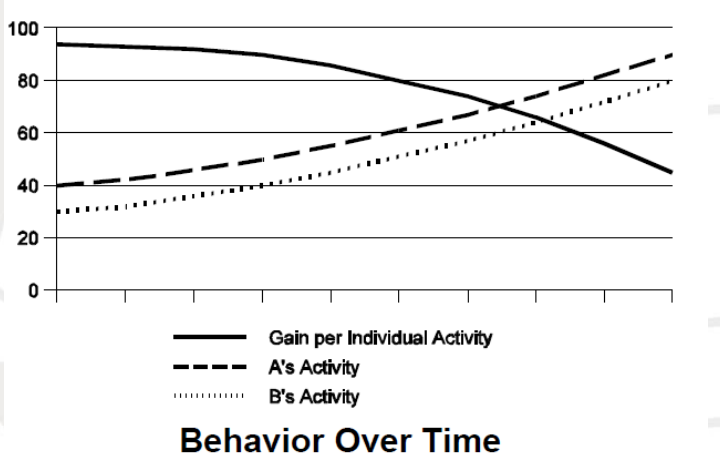




Tragedy of the Commons

- The sum total of two or more reinforcing activities strains a limited resource and creates balancing consequences for all.
- If total usage of a common resource grows too great, the commons will become overloaded or depleted, and everyone will experience diminishing benefits.
- Lawmaking examples
  - State government building new highways, leading to higher population, more cars using the resources, and then congestion for all





Outline

- Introduction and Background
- Review of Model Elements and Structures
- Causal Loop Diagrams
- Structure – Behavior Pairs
- System Archetypes
- Conclusions and Future Work
- References
- Backups

Conclusions and Future Work

- This work provides reusable model structures and behaviors interpreted and tailored for the lawmaking process domain.
- The generic structures are starting templates that can be combined in different ways, and with detail added to create larger infrastructures and complex models.
  - Modelers can save time with reusable building blocks leveraging existing patterns. The structure – behavior pairs form a reusable library.
- System archetypes are effective tools to gain insight about patterns of behavior that emerge from the underlying system structures.
  - They can be used diagnostically to reveal insights into the existing systems, or prospectively to anticipate potential problems and/or problem symptoms.
- Subsequent work includes more small scale models demonstrating system archetypes in lawmaking, and more elaborated, complete model applications.
  - Web-based, executable versions will be accessible for public usage of the lawmaking applications.
- This work is a beginning as there are numerous law topics to investigate aided by simulation.
- The models are for insight and impact, not just for play. The goal is to interject use of models and simulation into actual lawmaking practice.

References

- Bodner, Douglas A. "Mitigating Counterfeit Part Intrusions with Enterprise Simulation", Procedia Computer Science 61, Elsevier (2015): 233 – 239
- Derwisch, Sebastian and Kopainsky, Birgit. "Dynamics of Enforcement and Infringement of Intellectual Property Rights and Implications for Innovation Incentives", Proceedings of the 28th International Conference of the System Dynamics Society (2010)
- Forrester, Jay W. *Principles of Systems.* Cambridge, MA: MIT Press, 1968.
- Forrester, J. W., *Urban Dynamics*, Cambridge MA: Productivity Press, 1969
- Ghaffarzadegan, Navi, et al. "How Small System Dynamics Models Can Help the Public Policy Process", System Dynamics Review 27(1): 22-44., System Dynamics Society, 2011.
- GovTrack, "Historical Statistics about Legislation in the U.S.Congress", https://www.govtrack.us/congress/bills/statistics (last accessed October 2016)
- Hines, Jim. *Molecules of Structure Version 1.4*, LeapTec and Ventana Systems, Inc., 2000.
- Levin, G., et al. *The Persistent Poppy: A Computer-Aided Search for Heroin Policy*. Cambridge MA: Ballinger, 1975.
- Madachy, Raymond J. *Software Process Dynamics,* Hoboken, NJ: Wiley-IEEE Press, 2008.

References (Cont.)

- Meadows, Donella H., et al. *The Limits to Growth*, New York: Universe, 1972.
- Meadows, Donella H., et al. *Limits to Growth-The 30 year Update*, White River Junction, VT: Chelsea Green, 2004.
- Morecroft, J. D., "System Dynamics and Microworlds for Policymakers", European Journal of Operational Research 35 (3): 301-320, 1988.
- Olaya, Camilo and Angel, Vanessa. "The War on Drugs: A Failure in (Operational) Thinking", Proceedings of the 32nd International Conference of the System Dynamics Society (2014)
- Richmond, Barry, et al. *Ithink User's Guide and Technical Documentation,* High Performance Systems Inc., Hanover, NH, 1990.
- Schrunk, David G. *The End of Chaos: Quality Laws and the Ascendancy of Democracy*. Poway, CA: QL Press, 2005.
- Senge, Peter. *The Fifth Discipline*. New York, NY: Doubleday, 1990.
- State of California, "OVERVIEW OF LEGISLATIVE PROCESS", http://www.leginfo.ca.gov/bil2lawx.html (last accessed October 2016)
- Sterman, John D. *Business Dynamics: Systems Thinking and Modeling for a Complex World*, Boston, MA: Irwin/McGraw-Hill, 2000.

Backups

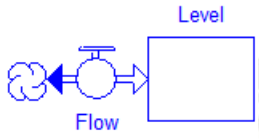
System Dynamics Principles

- Major concepts
  - Defining problems dynamically, in terms of graphs over time
  - Striving for an endogenous, behavioral view of the significant dynamics of a system
  - Thinking of all real systems concepts as continuous quantities interconnected in information feedback loops and circular causality
  - Identifying independent levels in the system and their inflow and outflow rates
  - Formulating a model capable of reproducing the dynamic problem of concern by itself
  - Deriving understandings and applicable policy insights from the resulting model
  - Implementing changes resulting from model-based understandings and insights.
- Dynamic behavior is a consequence of system structure
- The continuous view
  - Individual events are not tracked
  - Entities are treated as aggregate quantities that flow through a system, and can be described through differential equations
  - Discrete approaches usually lack feedback, internal dynamics

Generic Flows

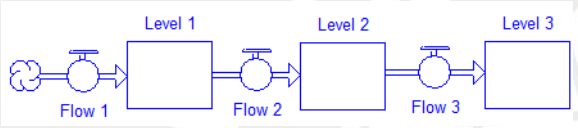
Rate and Level System

The simple rate and level system (also called stock and flow) is the primary structure from which all others are derived. This system has a single level and a bi-directional flow that can fill or drain the level. Subsequent structures each build on top of this basic structure with additional detail and characteristic behavior.



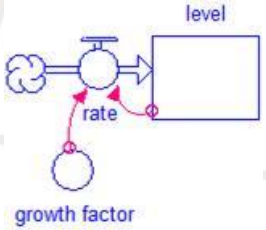
Flow Chain with Multiple Rates and Levels

The single rate and level system can be expanded into a flow chain incorporating multiple levels and rates. It can be used to model a process that accumulates at several points instead of one, and is also called a cascaded level system. A generic flow chain within itself does not produce characteristic behavior without other structure and relationships.



Compounding Process

The compounding structure is a rate and level system with a feedback loop from the level to an input flow, and an auxiliary variable representing the fractional amount of growth per period. A compounding process produces positive feedback and exponential growth in the level. Modeling applications include the initial rapid escalation of paperwork due to a new ordinance, compounding of new laws to fix previous laws, legal or illicit market dynamics, social communication patterns (e.g. rumors, panic), etc.

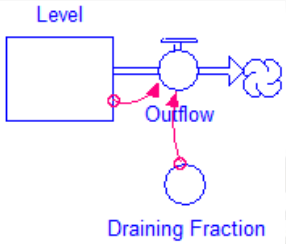


Rate = Level * Growth Factor

Generic Flows (continued)

Draining Process

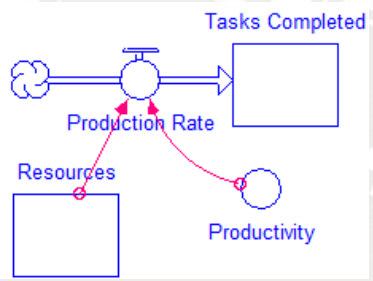
Draining can be represented similarly as the compounding process, except the feedback from the level is to an outflow rate and the auxiliary variable indicates how much is drained in the level. Draining is a common process that underlies delays and exponential decays. Case promotions, fine payments, personnel retirement, skill loss and other trends can be modeled as draining processes.



Outflow = Level * Draining Fraction

Production Process

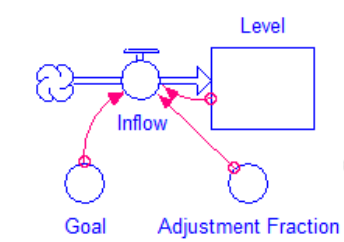
A production process represents work accomplished at a rate equal to the number of applied resources multiplied by the resource productivity. It typically has an inflow to a level that represents production dependent on resource amounts, which may be a level in an external flow chain representing resources. E.g., the productivity of levying traffic tickets can be modeled this way as a function of police employed.



Production Rate = Resources * Productivity

Adjustment Process

An adjustment process is an approach towards goals or equilibrium. The structure contains a goal variable, a rate, level, and adjusting parameter. The structure models the closing of a gap between the goal and level. The change is more rapid at first and slows down as the gap decreases. The inflow is adjusted to meet the target goal. This basic structure is at the heart of many policies and other behaviors.

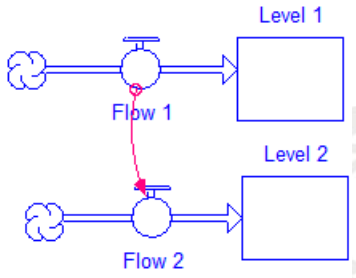


Inflow = (Goal – Level) * Adjustment Fraction

Generic Flows (continued)

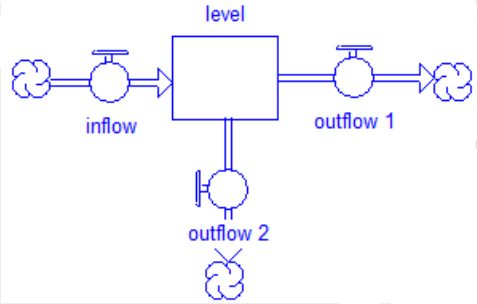
Co-Flow Process

Co-flows are a shortened name for coincident flows; flows that occur simultaneously through a type of slave relationship. The co-flow process has a flow rate synchronized with anot her host flow rate, and normally has a conversion parameter between them. This process can model the co-flows of laws and infractions, laws and associated paperwork, resource tracking such as effort expenditure, or tracking revenues as a function of traffic tickets levied.



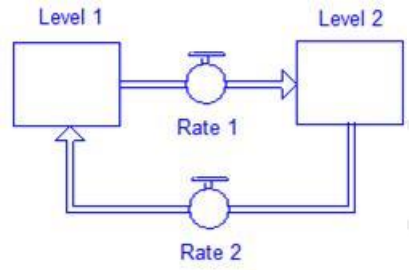
Split Flow Process

The split flow process represents a flow being divided into multiple sub flows, or disaggregated streams. It contains an input level, more than one output flow, and typically has another variable to determine the split portions. Applications include litigation chains to differentiate prosecution case successes vs. failures, other court judgments won vs. lost, or personnel flows to model legal personnel resource allocation to different activities.



Cyclic Loop

A cyclic loop represents entities flowing back through a loop. The difference from non-closed chains is that a portion of flow goes back into an originating level. This structure is appropriate to represent law amendments, retried cases, habitual re-offenders, and other cycling phenomena.



Example Infrastructures

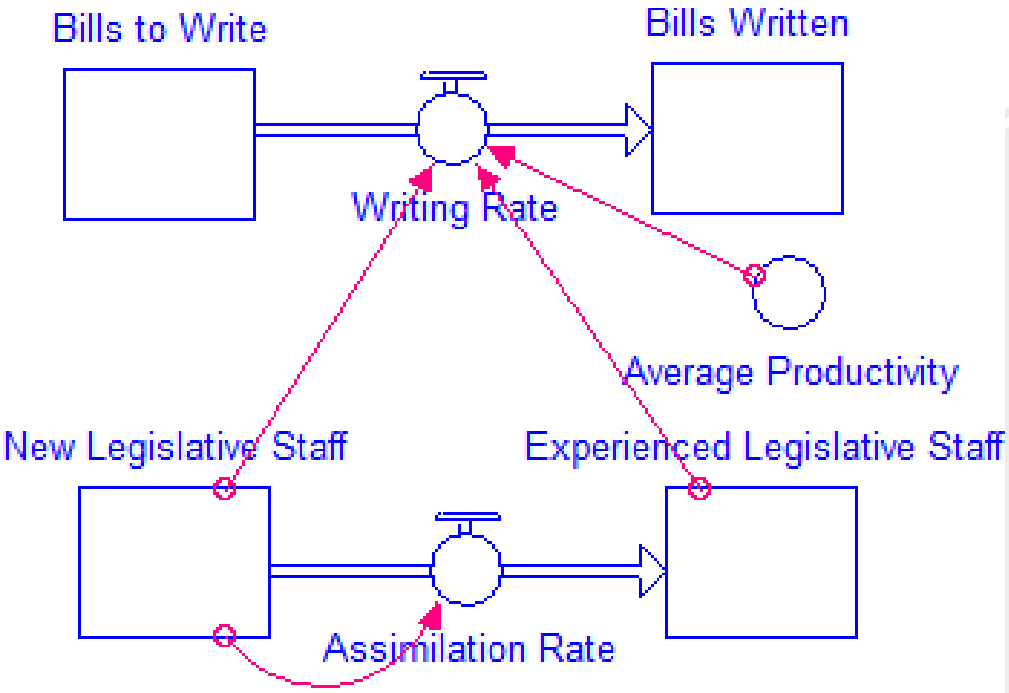
- Exponential Growth
- S-shaped Growth
- Delays
- Balancing Feedback
- Oscillation
- Smoothing
- Production
- Production Structure
- Learning Curve
- Attribute Tracking
- Attribute Averaging
- Effort Expenditure
- Decision Structures

* See paper for more detail and lawmaking process examples

Outline

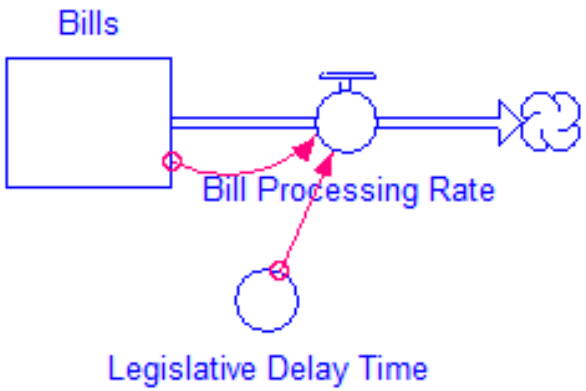
- Introduction and Background
- Structures
  - Elements
  - Generic Flows
  - Infrastructures
- Example Lawmaking Process Structures
- Demonstration
- Conclusions and Future Work
- References

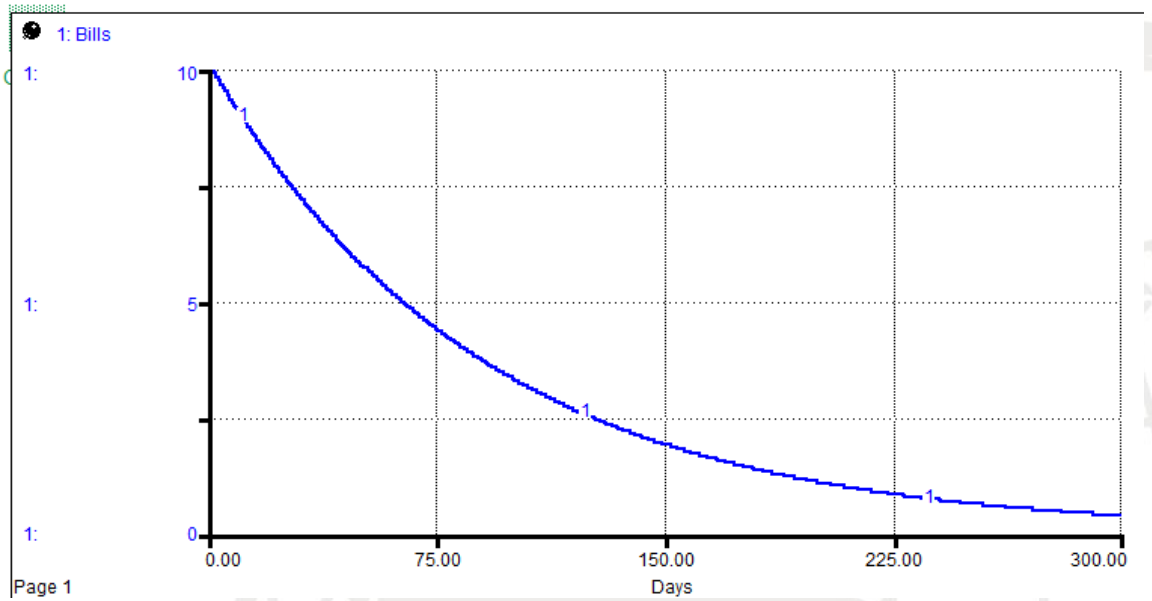
Example Production Structure



Writing rate productivity adjusted for experience levels

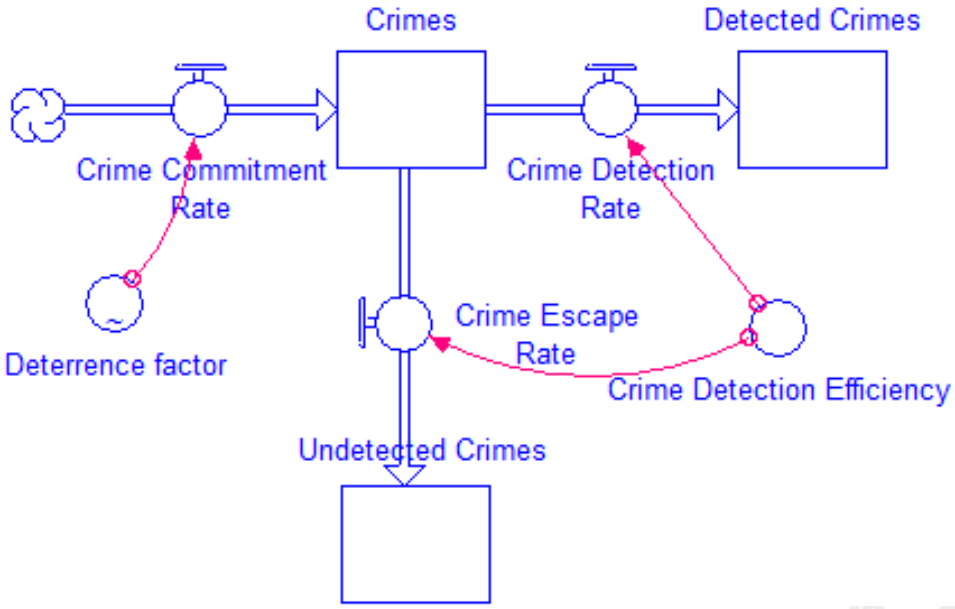
Example Delay Structure and Behavior





Bill Processing Rate = Bills / Legislative Delay Time

Example Crime Detection Structure

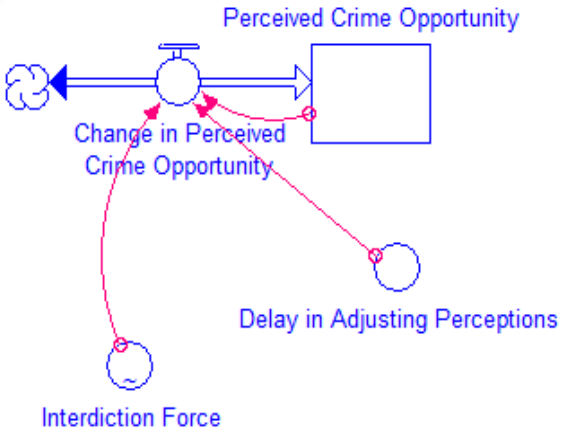


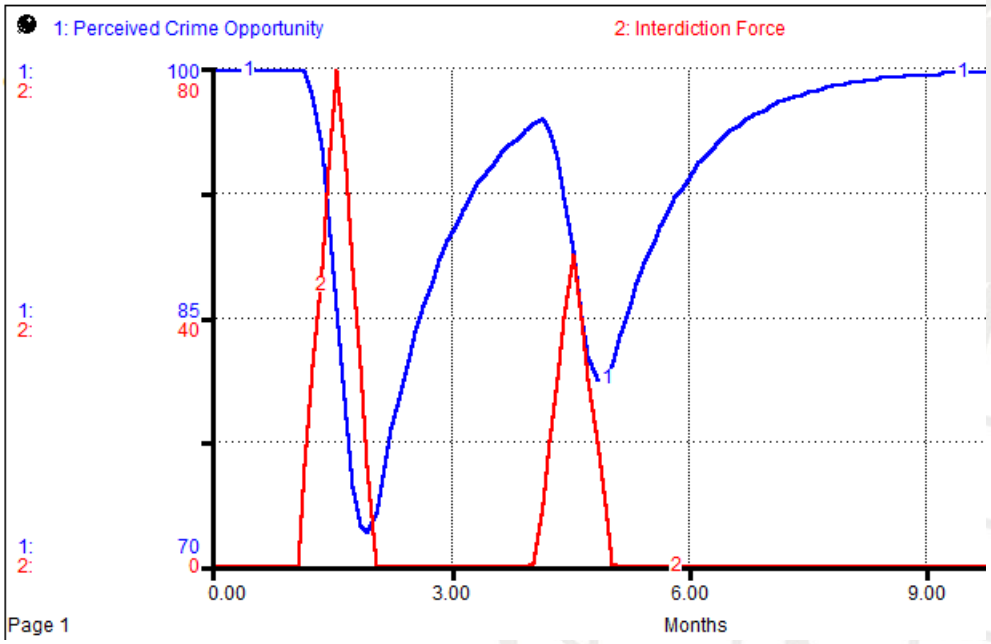
- Multiple level flow chain for crimes
- Split flow process

Crime Commitment Rate = Graph(Deterrence Factor)
Crime Detection Rate = Crime Detection Efficiency * Crime Commitment Rate
Crime Escape Rate = (1 - Crime Detection Efficiency) * Crime Commitment Rate

Example Information Smoothing Behavior

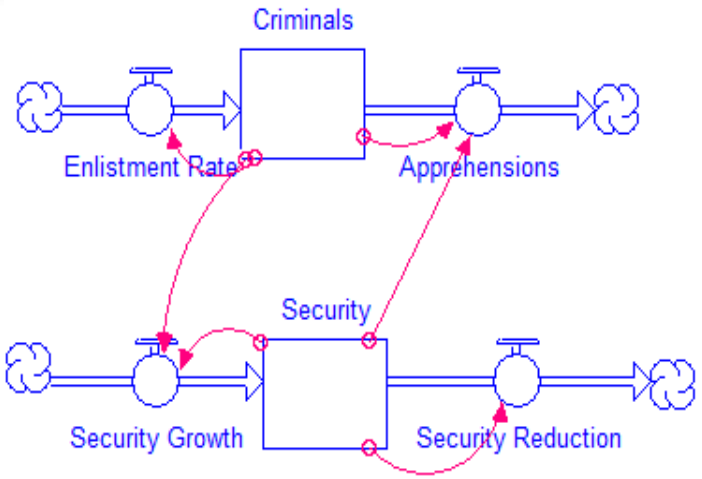
- Intermittent interdictions

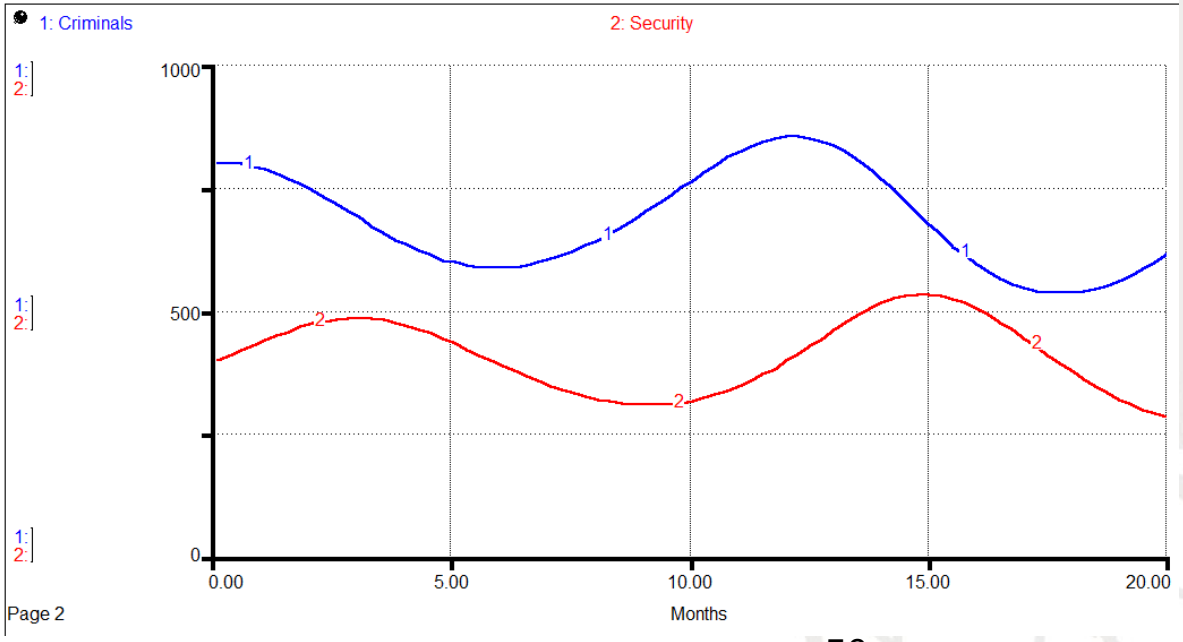




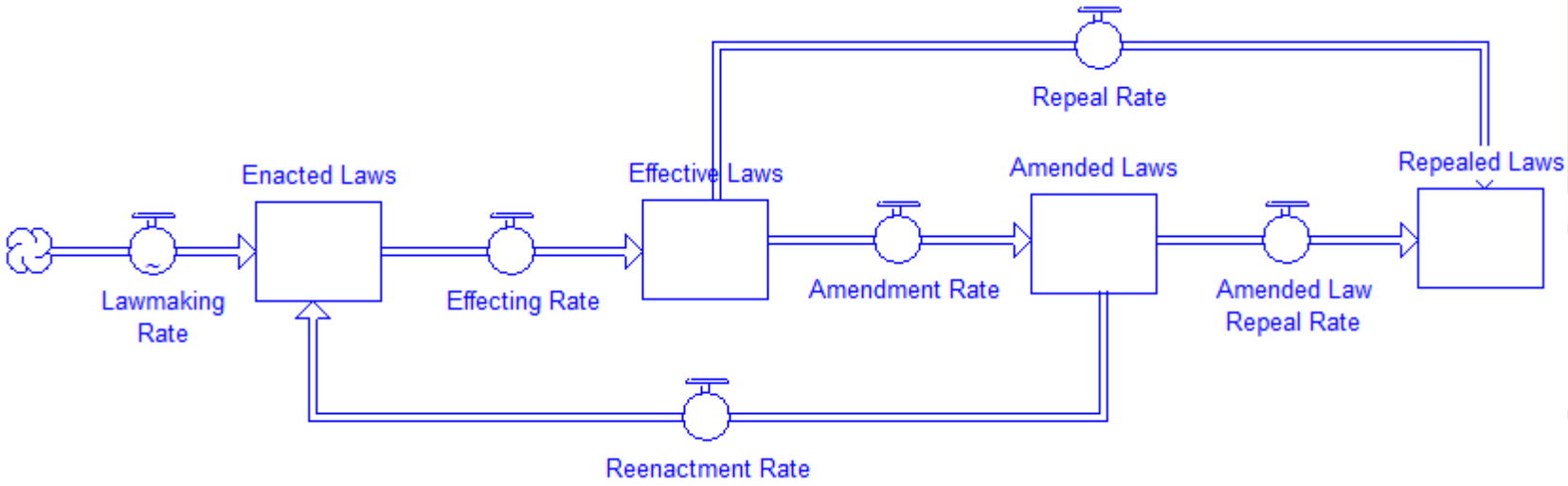
Example Oscillating Behavior

- Continuous forces in region as Predator-Prey model.

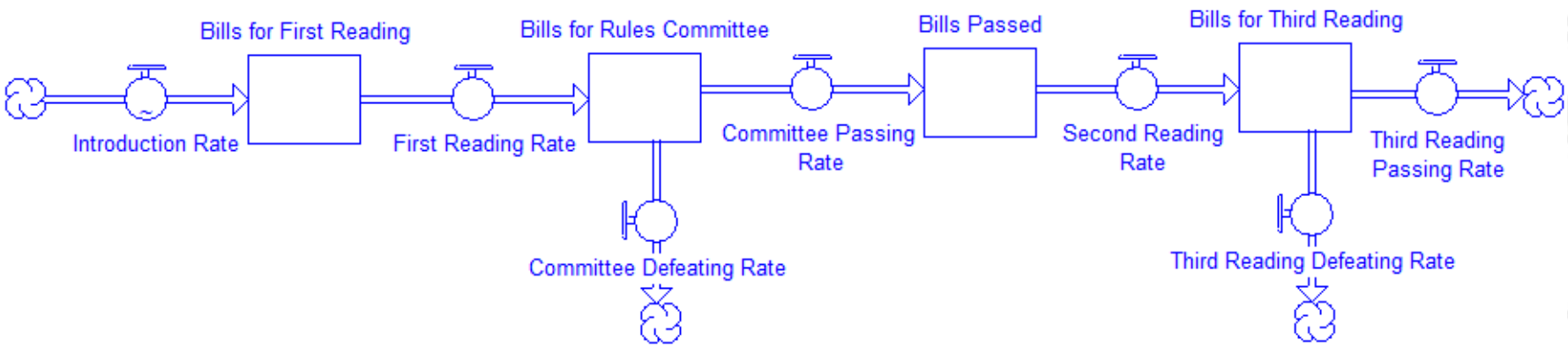




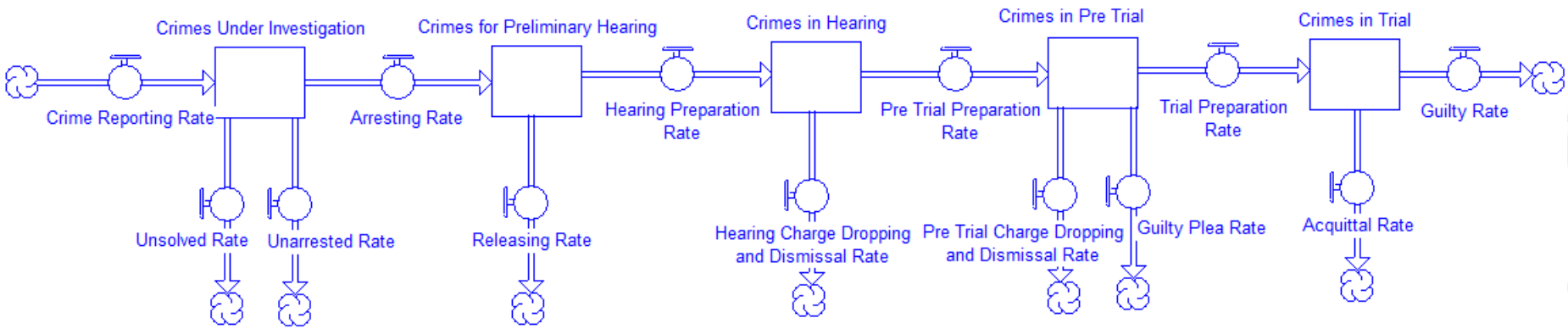
Lawmaking Flow Chain



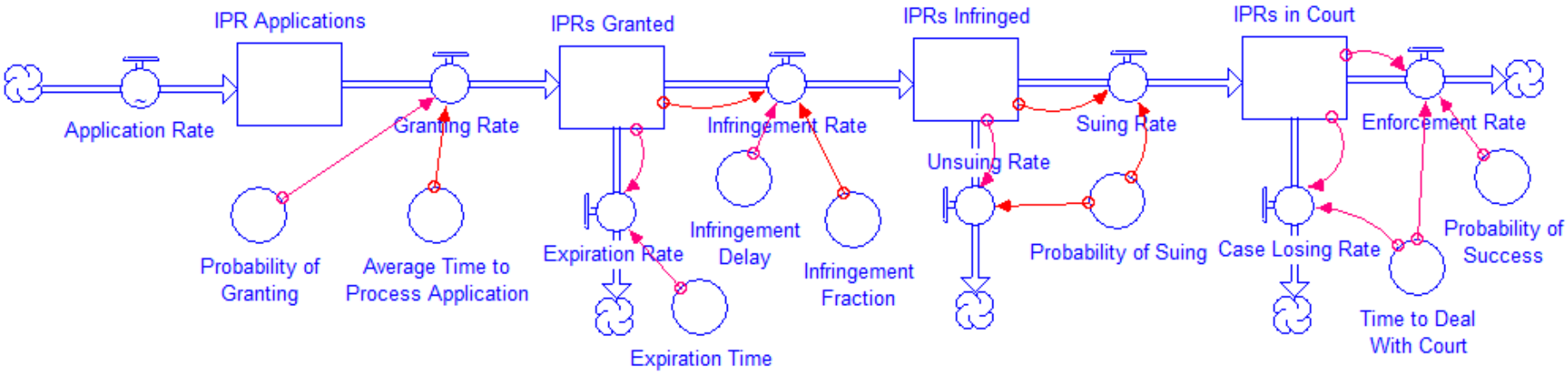
State Legislative Process Flow Chain



Criminal Justice Process Flow Chain

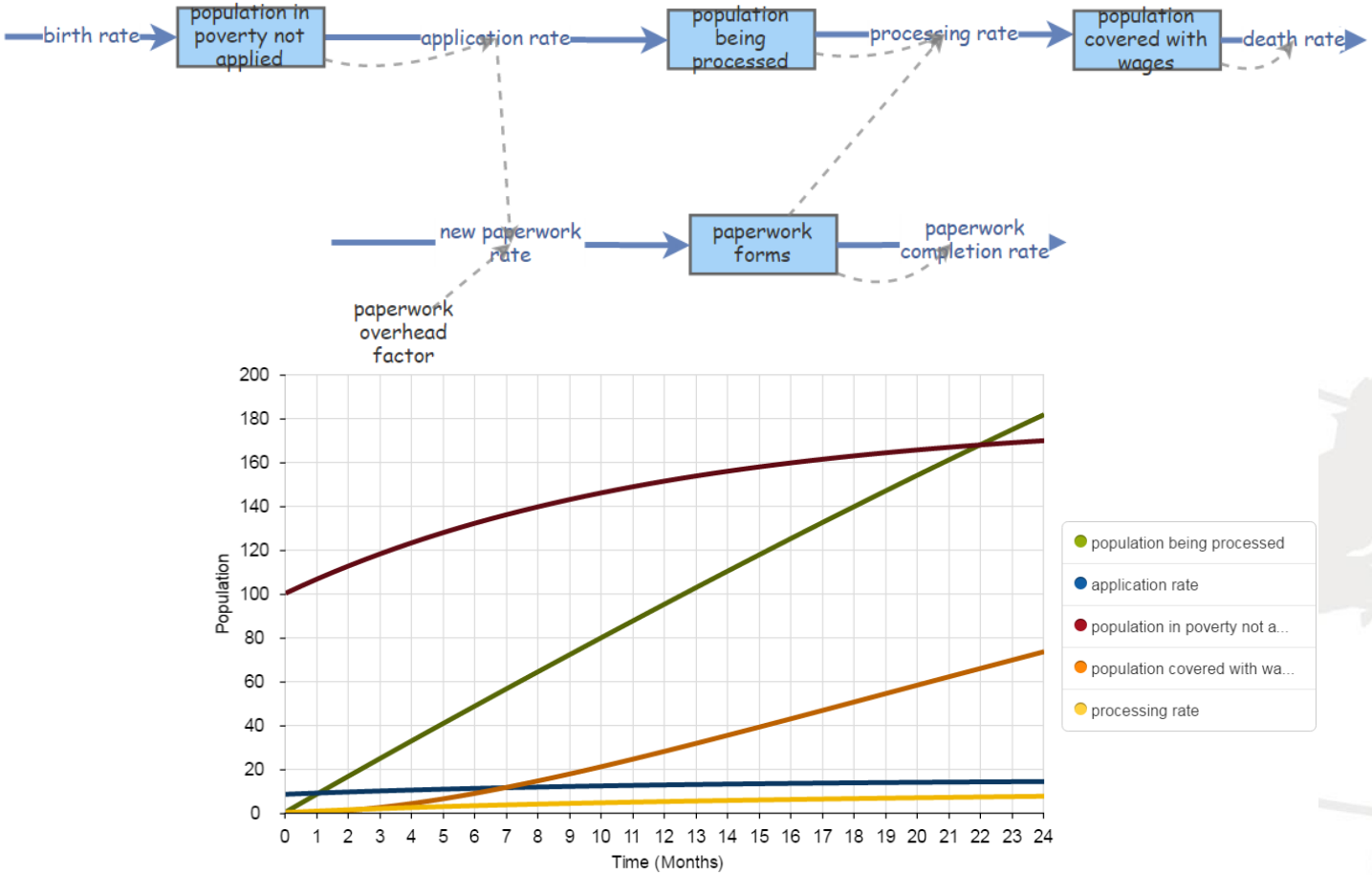


Intellectual Property Rights Flow Chain with Added Detail



Online Demonstration

- Anti-Poverty Law Unintended Consequences



- See http://scienceoflaws.org/models/ or http://sdsim.com/models/lawmaking/