THE SCIENCE OF LAWS JOURNAL
- Excellence in Governance through Science -

VOLUME 3, ISSUE 1

THE SCIENCE OF LAWS JOURNAL

Excellence in Governance through Science

"A good government implies two things: first, fidelity to the object of government, which is the happiness of the people; secondly, a knowledge of the means by which that object can be best attained. Some governments are deficient in both these qualities; most governments are deficient in the first. I scruple not to assert, that in American governments too little attention has been paid to the last." *–James Madison (1788)*

ATTAINING THE OBJECTIVE OF LAWS

I am pleased to bring you our third issue of *The Science of Laws Journal*. This issue is populated with the proceedings from our third annual conference held at the University of California, San Diego in conjunction with the International Council on Systems Engineering. Looking at these articles reminded me of the Madison quote above found in "The Federalist No. 62" (printed by *Independent Journal* in 1788). Through the effort of our authors and others in our field, we are collectively learning more about the means by which laws can attain the object of a good government: the happiness of its people.

Our first article delves into the topic of risk management. Written from the perspective of a seasoned technology veteran with vast experience in managing and executing technical projects, the article describes the purpose and general methodologies of risk management as they are applied by systems engineers and project managers. The author then shows how these same methodologies can be leveraged in to lawmaking. By applying these techniques, future lawmakers and the public affected by the laws will be more assured that the resulting laws will achieve the desired outcomes, not cause additional harm, and operate within the anticipated budgets.

Our second article examines the purpose of law. Surprisingly, even though laws have been in existence for millennia, there is no generally agreed upon purpose for law. Thus, without a unified purpose, resulting laws can be contradictory, confusing, and sometimes harmful. Within this article, the author proposes a short "symbiotic code" that could one day form a nucleus for the scientific purpose, methods, and measurements to improve laws.

Our third article helps build the foundation for system dynamics modeling relating to the lawmaking process. System dynamics help reveal phenomena and inter-relationships from a holistic perspective. In order to "jump start" the use of system dynamics modeling in lawmaking, the author provides reusable microstructures, infrastructures, and flow chains. With these building blocks available in print and online in an interactive format, lawmakers will be able to more quickly create models and simulate proposed laws.

I hope you enjoy this issue of the *Journal*. Further, I hope you get the chance to join us at the 4th Annual Science of Laws Conference currently being planned for November 2017 in San Diego, California. In the meantime, please check out the back page to see how you can contribute to the advancement of the science of laws and, in the spirit of Maddison, contribute to the happiness of the people.

–John Wood, Editor

JOURNAL INFORMATION

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PROCEEDING

Applying Risk Management to Lawmaking

Jim Gottfried*

ABSTRACT

Based on over 30 years of experience in managing and executing technical projects, the author provides a perspective on how risk management principles can and should be applied to laws of government.

Keywords: Lawmaking, risk management, risk identification

BACKGROUND AND DEFINITIONS

The fields of systems engineering and project management stress the importance of assessing and managing risks. According to the Project Management Institute, a risk is "an uncertain event or condition that, if it occurs, has a positive or negative effect on one or more project objectives such as scope, schedule, cost, or quality." In the context of lawmaking, one could easily replace the word "project" in the definition above with the word "law." Risk is a normal element of projects (and lawmaking.

Risks are assessed in terms of probability of occurrence and impact of occurrence. Often, a "Probability Impact Diagram" is used to illustrate the risk. A Probability Impact Diagram is an X by X graphic displaying the combined probability of occurrence for a specific risk and the impact to the project or law should that risk occur. In this diagram, red (i.e., danger), yellow (warning), and green (within tolerances) zones indicate the severity of the risk. While color-coding in this manner is common, each organization typically defines the ranges of each zone based on the risk tolerance of that individual organization and the project itself.

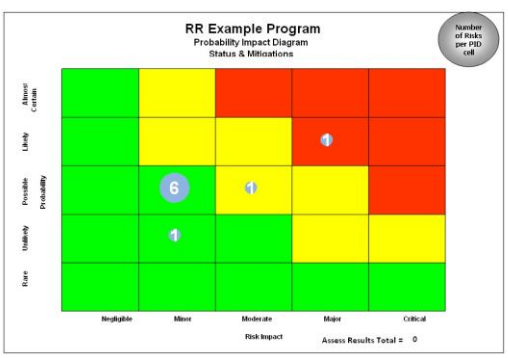

Figure 1: Example Probability Impact Diagram

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RISK CATEGORIES RELATED TO LAWMAKING

Based upon the author's experience in applying risk management to technical programs, risks often fall into the following categories: accomplishment risk, unintended-consequences risk, or cost risk. It appears these categories also apply lawmaking. Below are definitions of the risk categories as they relate to lawmaking.

Accomplishment Risk – Risk that the law will not achieve its intended purpose (whether stated or not). This could be driven by poor implementation or enforcement of the law (i.e., the executor ignores or misinterprets law) or by poorly written laws (i.e., laws that are ambiguous, incomplete, unenforceable, or unconstitutional).

Unintended Consequences Risk – Risk that the law will cause consequences that were not intended by the lawmakers. This could be directly related consequences which are often easy to predict in advance or indirect consequences which are typically difficult to predict in advance.

Cost Risks – Risk that the law will have a greater effect on finances due to under or over estimating costs relating to enforcement or implementation or the financial effect on economy (i.e., businesses, organizations, and individuals). This could be due to poor or incomplete estimates of cost or due to the law's inherent lack of flexibility to changes in environment, circumstances, or common beliefs and attitudes.

EXAMPLES OF ACCOMPLISHMENT RISK

The following are examples of accomplishment risk which were caused by poor implementation or enforcement:

- City of Encinitas, California not allowing builders to build in higher density if they provide low income housing
- Insufficient police support to enforce (e.g., parking regulations and cellphone use in cars)
- Judges who do not enforce law requirements due to bias, disagreement, or interpretation of the law

The following are examples of accomplishment risk which were caused by poor wording:

- Lawmakers giving implementers too much authority to interpret what law really means and how it will be enforced (equivalent of poor system requirements)
- California law to incentivize builders to include low income housing in developments by allowing greater density but ambiguous regarding the number of units allowed (e.g., if the calculation equates to X.5 units, does one round up or down?)

EXAMPLES OF UNINTENDED CONSEQUENCES RISK

The following are examples of laws that suffered from unintended consequences.

- Dodd-Frank – Significant new regulations on banks with significant fines allotted for non-compliance, yet the law does not specifically cause big banks to divest and get smaller
  - Very difficult and expensive for smaller banks to comply, results in less smaller banks, more mergers
  - Big banks (sometimes deemed "too big to fail") get bigger because they can better absorb compliance and increased costs
  - Large fines remove capital from banking system, transferring it to the Government, thus leaving less capital in private economy for loans to promote economic growth thus hurting shareholders and the economy not the perpetrators of the bad behavior
- Marijuana Laws – High taxes on legal sales encourage the continuation of black market sales
- California's Proposition 61 (November 2016 ballot) – May increase drug costs for Veteran Administration and other medical patients
- City of San Diego, California's Propositions C and D (November 2016 ballot) – what are the consequences of increasing hotel taxes to 16.5%? will it reduce tourism in the city?
- California's original "3 strikes" law – resulted in overcrowded prisons with 25 year-to life sentences for many non-violent criminals and for many less serious crimes such as shoplifting
- United States tax rates – Corporate taxes higher than in other countries
  - Corporations move to other countries
  - Corporations do not bring international wealth back to the U.S. thus not investing in the U.S. and contributing to growth in U.S. jobs and economy

EXAMPLES OF UNINTENDED CONSEQUENCES RISK

The following are examples of laws that suffered from poor cost estimates.

- 1999 law giving large pension increases to California state workers
  - Very poor and unrealistic estimates of future investment returns
  - Inadequate analysis and understanding of increasing life spans
  - Inflexible to future economic changes and circumstances in California's economy
- Affordable Care Act
  - Poor initial cost estimates; not properly modeled; bias in estimating
  - Too many promises not supported by budget analysis
  - No cost risk analysis that examined alternatives and consequences
  - No mitigation actions defined to address potential cost risks
- California High Speed Train
  - Very poor estimates of cost
  - No funding identified for entire project; will it actually be completed or will it be "a train to nowhere?"

RISK MANAGEMENT FUNCTIONS

In order to reduce the likelihood and/or impact of risks (such as those illustrated above), lawmakers should conduct risk management activities in a continual, iterative and dynamic manner throughout the entire life-cycle of the law (i.e., from initial concept development through to retirement of the law).

Figure 2: Risk Management Functions

The legislators, supported by staff (including system engineers) and constituents, should have the responsibility for identifying and managing risks that can result from the law enactment. One key technique for managing risk in lawmaking is to build in the flexibility to modify the law if certain consequences (risks) occur. However, based on the many examples of risks occurring in laws, planning for risk mitigation does not appear to be required or accomplished on a regular basis.

ROLE OF THE SYSTEM ENGINEER IN RISK MANAGEMENT OF LAWS

Systems engineers participating in risk management of laws can and should fulfill several roles. Some examples include:

- Identifying risks
- Creating risk mitigation strategies
- Modifying laws to avoid or mitigate unwanted consequences or costs
- Monitoring status of identified risks as the law is implemented and as it matures
- Managing risk mitigation activities in a manner that is timely and achieves objectives
- Modifying laws based on changing risk profiles
- Closing risks once they have been mitigated or are no longer a concern

PROPOSED RISK IDENTIFCATION ACTIVITIES

The first and, perhaps, most important activity in risk management is to identify risks. During lawmaking and after implementation, lawmakers should conduct law performance sessions with implementers and constituents to identify risks, mitigations, and responsibilities. During these sessions, they should identify possible consequences (risks) including accomplishment risks, unintended consequences risks, and cost risks. Lawmakers should model law operation to further refine their understanding of potential unintended consequences, costs, population behavior, etc. Additionally, throughout the process, the lawmakers should prepare and update a risk register capturing the following information:

- Description of risk, its type/category and a unique identification number
- Risk impact statement (i.e., what effect does it have on law implementation success and cost?)
- Probability of occurrence (likelihood) and impact of occurrence (consequence)
- Risk severity (rank) (often associated with where it lies on the Probability Impact Diagram)
- Risk owner to which it is applicable (i.e., lawmaker, implementer, constituent, etc.)
- Mitigation activities both prevention and contingency complete with:
  - An estimate of the reduction in risk (in terms of probability, impact, or both) that will occur from mitigation activity
  - The residual risk remaining
  - When the mitigation activity is needed
  - The estimated cost of performing the mitigation
- Estimates of when the risk may be closed

CONCLUDING THOUGHTS

Laws are systems that are developed and deployed. Therefore, systems engineering principles are likely to prove beneficial for law design and management of law-related risks. Systems engineers are trained to write requirements that are necessary, unambiguous, concise, complete, consistent, realistic (bounded and implementable), affordable, enforceable, and accomplish the desired goals without creating unreasonable risk. Laws should be written in the same manner so that they can best support society with minimal risk of failing, creating unintended consequences, or costing more than planned.

While lawmakers should perform these risk activities during law formulation, they should also continue these activities throughout the total life-cycle of the law including implementation and operation through to retirement.

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International Council On Systems Engineering (2015). *Systems Engineering Handbook*. San Diego, CA: International Council On Systems Engineering.

Jim Gottfried is currently the Instructor for the UCSD Extension course System Engineering Software Overview. Jim has over 40 years of experience in systems and software engineering including functional and program management related to these disciplines. Jim has held positions from software/systems engineer to a Division VP. Jim's computing and software experience includes being the Chief Engineer for Computer Resources and Software for Lockheed Martin's F-22 Fighter. Jim has also managed multi-million dollar programs for radar delivery, air traffic control radios, USAF Special Forces air systems, and various IT computing systems. Jim is currently a consultant to companies and organizations that need development and review support for technical proposals being submitted to Government and commercial clients.

Jim's teaching experience includes program management, risk management, and systems engineering for companies; and operations research and mathematics at the university level. Jim has been a member and leader of the International Council on Systems Engineering, San Diego Chapter, for over 15 years. He has held a variety of board positions including President. Jim was also a certified Professional Program Manager (PMP).

PROCEEDING

A Symbiotic Code for Providing Purpose and Scientific Structure to Legal Systems

Peter Wallis*

ABSTRACT

There is no generally agreed upon purpose of "law." Law-making by legislators, unguided by a general purpose, can lead to laws which are contradictory, confusing, and sometimes harmful. Executive action and judicial rulings interpreting this legislation unguided by scientific purpose, methods, or measures may compound these harmful effects. Man-made laws are void when in conflict with natural law, facts, scientific purposes, or methods. A verifiable purpose for law can be scientifically deduced based upon observation of biology and human history. A proposed short "symbiotic code" may form a nucleus for the basic scientific purpose, methods, and measurements to improve laws. A reasonable hypothesis is that the purpose of law is salient communication in mutual decisions regarding reallocation of resources rewarding those causing mutual benefit and detracting those causing mutual risk or damage in the acquiring, preserving, and efficiently utilizing resources to aid in the perpetuation of symbiotic lives.

The problem here addressed is that the Anglo-American system of law has built an incomprehensible mass of legislative, executive, administrative, and judicial decisions which are often contradictory, confusing, and harmful to society. This problem exists largely because there is no generally accepted purpose for law, the law often is not restrained to act through proven scientific methods, nor are the results of laws designed to be objectively measurable in relation to their general purposes.

THERE IS NO UNIFIED PURPOSE OF OUR LEGAL SYSTEM

Many, if not most, legal scholars will readily admit that the legal system has some clear contradictions and deficiencies. The law has always been in need of a generally agreed upon purpose or a comprehensive set of guiding principles.

Bodenheimer (2004) stated "[T]here is no general agreement among jurists and other legal thinkers as to what the goals and purposes of legal regulation are or ought to be." (Bodenheimer, Okley, and Love, p.1) and "The development of legal institutions has not been a product of logic or convenience but was wholly developed through legally accepted fictions." (p.28) Rendleman (1999) stated "Legal development in a common law system is ragged and piecemeal; it is pressed forward, not by any urge for overarching consistency, but by the adversary system fueled by an individual lawyer's desire to win a client's case." (p.13) According to Professor Roscoe Pound, (1930) Ideas of what law is for are debatable and are also largely implicit in ideas of what the law is. (p.60-67) and "…primitive law is made up of simple, precise, detailed rules for definite narrowly defined situations. It has no general principles." (p.101)

Because the foundation for our legal system is more based upon the adversarial system than by scientific inquiry or scientific method, it is not surprising that laws have been in conflict for thousands of years. The code of Hammurabi in 1735 BC, lists hundreds of micro-edicts from the prince rather than any general principles as guidelines. The Ten Commandments, although beneficial and influential even today, does not express the reasoning behind them other than the will, acts, and judgements of God. (Exodus 20, 1-17) Even Moses wrote hundreds of supplemental laws to the Ten Commandments to regulate Israeli society in Exodus and Leviticus. The Maxims of Equity are fewer in number but are neither a comprehensive code nor are deduced from any overarching concepts. Rendleman (p.245)

Where there have been attempts at defining general principles of law, they have not been successful. The philosopher Jesus said, "In everything, do unto others what you would have them do unto you" (Matthew 7:12 NIV) This "golden rule" ignores the fact that most people want something for nothing. Doing good to others when others do not do good in return would quickly lead a man or a kingdom to financial ruin.

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FUNDAMENTAL CONTRADICTIONS AND CONFUSIONS ARE CAUSED BY A LACK OF PURPOSE FOR LAW

Man-made law, unguided by scientific purpose and unregulated by scientific measurement, can create chaos in a legal system.

The 800 year old Magna Carta was supposedly a turning point in Anglo-American law by replacing law based on *"the pleasure of the king"* with vesting specific rights to Barons and common people. The Magna Carta stated in part "to none will we sell, to none will we deny, or delay right or justice." But even those vague principles seem to not be taken seriously because the legal system is fundamentally designed to sell, deny, and delay justice unreasonably.

Justice is generally sold in both civil and criminal cases. As a matter of law, attorneys in every state are licensed by their states to be officers of their courts. In this capacity they offer representation and advice to secure real legal advantages to their clients. Yet generally these attorneys perform this service as a bargain in consideration for significant sums of money paid to them directly from their clients. Thereby the court system is generally designed to sell justice to the highest bidder.

The system is designed to deny justice. The Anglo-American court system gives rights to bring both legal and equitable actions. Equitable actions were developed on the presumption and fact that the common law was sometimes harsh, inflexible, expensive to litigate, and often did not provide adequate relief. (Bodenheimer, p.48) This system of equitable remedies is not an absolute right. Equitable relief can be granted or denied at the discretion of a judge and never a jury. (Rendleman, p. 2 and p.10) So a litigant has no right to equitable relief, no right to relief from harsh, inflexible and unjustly applied laws. Therefore the system is designed to deny justice.

Justice is unreasonably delayed. It is well known that lawsuits can involve lengthy discovery, investigation, hearings, and legal research. They can employ many attorneys and judges, and still last years or even decades after a trial. This is true even where there may be enough clear and pertinent facts to briefly summarize the case on one page of paper. The average law student or bar examinee would be expected to read a similar set of facts, identify legal issues, recite the law from memory, and write an analysis in about an hour. Therefore, the legal system is apparently designed for justice to be unreasonably delayed.

The United States Constitution increased the power of the federal government but in no way resolved the contradictions of the law. The American Civil War, in part, was arguably fought because of fundamental legal contradictions.

The Constitutions' preamble, in part to "…establish justice, ensure domestic security, provide for the common defense, promote the general welfare…" may be an inspiring platitude but these key terms still remain undefined. It is too vague. It demands debate on what justice and the general welfare are. Is justice and general welfare a working person's right to keep wealth he has earned for himself or is justice and general welfare the right of a non-working poor person to receive wealth from others so he can survive and be healthy? This remains a fundamental unresolved legal problem.

With no unified purpose of law, the resulting confusion and chaos allows manipulation of the laws for personal benefit. There is nothing new about this. At common law, the king reserved to himself the power to "do justice" outside of the courts and to overrule the courts. If a friend of the king did not get a ruling he liked in common law courts, he could appeal directly to the king. (Bodenheimer' p.49) A similar process continues today as legislative and executive elections are largely funded by private or corporate campaign donors who generally expect quid pro quo.

CONTRADICTIONS IN THE FOUNDATION OF LAW ARE COMPOUNDED BY LEGISLATIVE, EXECUTIVE, AND JUDICIAL DECISIONS

Our legal system presumes that legislation will sometimes be vague or unjust and leaves it to the courts to provide clarity or correct minor problems from unforeseen situations. The problem is that, absent fundamental guidelines, the courts often uphold laws in clear conflict with other laws or in conflict with the Constitution. Consider the following clear and controversial conflicts and note that very few people would always side with the Constitution or the ruling Court.

The 1st Amendment of the Constitution provides for freedom of speech without exception, yet there are certainly laws to the contrary. (Emanuel, 2012) "[Exceptions to freedom of speech are] obscenity, fraudulent misrepresentation, defamation, advocacy of imminent lawless behavior, and fighting words." (p. 479)

The 2nd Amendment states that the right of the people to keep and bear arms shall not be infringed, yet there are many federal, state, and local laws limiting possession and ownership of firearms. Some of these laws prohibit the loading, possession, or display of such firearms. (Californai Department of Justice, 2016)

The 4th Amendment of the Constitution in part gives people the right to be secure in their persons and effects from searches except upon specific warrant and based upon probable cause. Yet the Federal Transportation Security Administration conducts an average of 1.9 million warrantless searches of persons every day and almost twice that number of searches of person's bags. Nor are any of these searches based on probable cause; approximately one search in 277,000 would find a firearm. While the alleged purpose of the searches is airline safety, the TSA reports contraband found to local police even for legal infractions as minor as possession of minute amounts of marijuana which hardly affects airline safety. (Transportation Security Administration, 2016)

The 5th Amendment of the Constitution states that private property shall not be taken for public use without just compensation. However, there is no legal "taxpayer standing" for a tax payer to challenge a tax law (with some exceptions) even where the tax doesn't benefit the tax payer. *Frothingham v. Mellon*, 262 U.S. 447 (1923). If this taxation is for a public use, the taxed person should be promptly compensated dollar for dollar of what he pays in taxes. If this taxation is for private benefit of the recipient contrary to public use, the taxation is arguably a larceny performed by the government.

The fundamental right to freedom is guaranteed under the 14th Amendment and cannot be denied without due process of law. Nonetheless, a mere executive order signed by the president is all the due process necessary to evict, round-up, and send 110,000 innocent men, women and children away to United States concentration camps. This order can be based only on their Japanese ancestry. *Korematsu v. United States*, 323 U.S. 214 (1944)

Boyce (2010) observed that in the early statutes of England and by American common law, sodomy (AKA, anal sex) was a felony (p.465). In 1986 the Supreme Court affirmed a state law punishing homosexual sodomy with up to 20 years in prison. *Bowers v. Hardwick*, 478 U.S. 186 (1986). According to the 10th Amendment of the Constitution, this ruling would be appropriate because states have powers to make laws except where prohibited by the Constitution. However, 17 years later the Supreme Court overturned the *Bowers* ruling on constitutional grounds and prevented states from making sodomy illegal. *Lawrence v. Texas*, 539 U.S. 558 (2003). This shows the arbitrary and fickle nature of the courts in reaching fundamental decisions even where they are supposedly based on the Constitution.

In criminal procedure law, and based on the 5th Amendment, coerced confessions are unconstitutional. However, Emanuel (2009) stated that most criminal case convictions are achieved through "plea bargaining" where the prosecutor uses threats of a much longer or harsher sentence if the defendant does not confess to a crime (p.360-361).

In criminal law, the mother of a fetus has the right to have her child killed in the womb at her sole discretion. *Roe v. Wade*, 410 U.S. 113 (1973). Between 1990 and 2007, approximately 1.2 million mothers per year exercised that right. (United States Census Bureau, 2012) The 14th Amendment of the Constitution holds that people have the right to equal protection of laws. Theoretically, equal protection of laws cannot be denied on the basis of gender. *U.S. v. Virginia,* 518 U.S. 515 (1996). However, when a father kills his own fetus, he can be tried, convicted, and imprisoned for murder. *People of California v. Scott Lee Peterson,* Appellate Brief S. 132449 (2004).

Regarding drug enforcement laws, alcoholic beverages cause one death in 10 in the United States, and cigarette smoking is both highly addictive and the leading cause of preventable death in the United States. Meanwhile marijuana use has arguably never caused a lethal overdose in a healthy person. (Dirk Lachenmeier & Jürgen Rehm, 2015). Yet it is marijuana production and distribution which carries severe state and federal criminal penalties.

According to Pound (1930) In contract law, a person can sell a piece of property for $20,000 even though the value is only $200 and a court of law and equity will uphold the contract. (p.274) This is true even though the transaction seems to be clearly a swindle because there is an "adequacy of consideration."

Weisburg (2011) notes that in family law, a divorcing parent who is deprived of custody and/or visitation of his child to his former spouse is further harmed because he must also typically pay a percentage of his income for "child support." (p. 169). This is in spite of the fact that married people who live with their children need not legally spend any particular percentage of their income on their children. Also, in most states, a single person with adequate finances may adopt a child without additional income from another parent.

In conclusion to this section, our legal system renders decisions which are clearly arbitrary, contradictory, confusing, and harmful to society.

MAN-MADE LAWS ARE VOID WHEN IN CONFLICT WITH FACTS OR NATURAL LAW

Much of the reason why the legal system can be so contradictory is that it does not ground itself in scientific purposes, methods, or measurements. This means that man-made laws can easily conflict with facts. Laws which are not subject to scientific measurements run the risk of remaining enforceable laws while clear damage is being done by them to society.

Part of the confusion disconnecting science from law is that the word "law" can mean two contradictory things. The definition of man-made law is a system of rules by which a community regulates itself. The definition of a natural law is a statement of fact, deduced from observation, to the effect that a particular phenomenon always occurs if certain conditions are present. (New Oxford American Dictionary, 2005).

Examples of man-made laws are rules that one should stop at stop signs, pay taxes, and not commit theft or murder. Examples of natural laws are that two plus two always equal four, that the surface area of a square can be determined by its base times its height, or that objects in motion tend to remain in motion until acted upon by an unbalanced force.

Natural laws and man-made laws may coincide, be irrelevant to each other, or they may conflict with one another either in purpose, method, or measurement.

As a hypothetical example of a conflict between man-made law and natural laws, imagine the federal legislature promulgated a national law for creating greater immediate wealth for all retirees. In this hypothetical law, each tax payer under age 62 would be required to immediately deposit $100,000 into a non-invested retirement fund and immediately receive $200,000 upon achieving a retirement age of 62. Plus, those already older than age 62 need not contribute any amount to the fund and may immediately receive their $200,000 upon the passing of the law.

The conflict here between the legislation and the natural law is that, by the natural law of arithmetic, neither zero nor $100,000 ever equals $200,000. No net wealth to society is increased because congressional legislation hasno effect upon the laws of arithmetic. In spite of the stated intent of the law, the result is those already 62 upon the passage of the law will glean $200,000 benefit from the law, those soon retiring will glean $100,000 benefit from the law, and the younger group of retirees will all lose $100,000 because of the law.

In this example, this law has no scientific purpose because it does not generally aid in acquiring, preserving, and efficiently using resources (explained extensively infra). It simply transfers wealth from younger people to older people without any reciprocal benefit. It is approximately like larceny. This law has no scientific method since it clearly conflicts with proven principles of mathematics and finance. The law also may have no scientific measurements because it does not allow for review to discover how well the scientific methods are succeeding with the scientific purpose. This type of retirement law is about as scientific as burning people as witches yet it also roughly describes the financial theory behind the nation's social security system.

How the law treats conflicts between man-made legislation and natural law is the opposite of what happens in fact. Article. VI of the United States Constitution states in part "**This Constitution, and the Laws of the United States** which shall be made in Pursuance thereof; and all Treaties made, or which shall be made, under the Authority of the United States, **shall be the supreme Law of the Land**…" (Emphasis added)

The Constitution claims that man-made federal laws are the supreme law and does not make exception for natural laws or natural purposes. However, neither the Constitution nor Congress have any authority to legislate math, geometry, science, facts, or the purpose of law.

Any man-made law in conflict with natural law, facts, or purposes of law is void.

Regardless of the Constitution's 1st Amendment prohibition of an establishment of religion, the legal system seems to require a faith in leadership regardless of clearly observable facts and principles to the contrary. A good cure for this harmful superstition may be the presentation of conflicting scientific observation.

A PURPOSE FOR LAW CAN BE SCIENTIFICALLY DEDUCED FROM OBSERVATION, BIOLOGY AND HISTORY

In biology, all living things are cellular. All cells have certain methods to acquire, preserve, and efficiently use resources to continue their current and residual lives. All cells use these methods to compete with other cells because resources are eventually limited. Some of these methods of competition are specialized cooperation with other particular types of cells for mutual benefit. This cooperation of cells produces many types of multi-celled organisms such as plants and animals. One of these cooperative multi-celled animals is Homo-Sapiens-Sapiens also known as mankind.

In the pre-history and history of man, people banded together for mutual benefit in acquiring, preserving, or efficiently using resources by forming nuclear and extended families. Families then banded together for the same reasons to form clans, which banded together to form city states, then kingdoms, then empires. So while the vast majority of approximately ten trillion cells in each person's body was both contributing to and benefitting from the biological alliance within that body, there was a similar alliance of millions of human bodies for the same purposes.

If we can reliably observe that the unifications of our bodies, families, communities, states, and nations are mere continuations of the cellular cooperative competition for resources, we have evidence of both the biological mandate and the fundamental scientific methods of that cooperation.

People within these cooperative unions tend to instinctually align themselves with, or disenfranchise themselves from, alliances and laws based upon their individual perception of risk or benefit. The scientific purpose then is mutual cooperation for benefit or reduction of risk and the primary method is reliable communication in encouraging contribution and discouraging degradation of mutual resources by appropriately distributing reciprocal benefits and detriments.

The idea is not new nor untried. To the contrary, the method is innate and has been used for thousands of years. Sun Tzu stated in The Art of War "If the leaders…shar[e] both the gains and the troubles of the people, then the troops will be loyal and naturally identify with the interests of the leadership." (T. Cleary, Trans., 1988, p.44)

A PROPOSED SYMBIOTIC CODE AS A SOLUTION

A proposed short "symbiotic code" may form a nucleus for the purpose of a legal system and form a scientifically measurable standard for that system. Basically put, this code could be based on the hypothesis that people can benefit through mutual cooperation by being required to communicate candidly, honor mutually beneficial agreements, avoid unprofitable risks, observe scientifically derived government rules, proportionately reward those who are mutually beneficial, and restrain or glean proportionate compensation from those who have risked damage to others. Here is an example of such a code:

Wallis Symbiotic Code:

"Disclose information so others interacting may protect themselves from dis-advantage, and honor predictably mutually-beneficial agreements, and don't act to cause predictable risk of net damage to self or others, and conform to scientifically reviewed governing rules of these same standards, except in the least damaging way necessary, to prevent a greater predictable risk of net damage, or to extract proportionate compensation for damages

predictably risked, or to extract proportionate compensation from greater un-earned benefits received, all to align individual interests with interests of others in symbiotic union, to efficiently produce, conserve, and utilize resources for symbiotic lives."

Here are some reasons why this might be a good foundation for law. It is intuitive: Teamwork is an innate concept in human relations. It is concise: It is one sentence of approximately 100 words including only four rules, three exceptions, two quasi procedural guidelines, and one guiding principle. It is timidly conservative: It does not, of itself, necessarily eliminate any existing laws; rather it provides criteria to challenge existing laws to see if they should be kept, modified, or removed. It also provides a standard for evaluating and promulgating new laws. It is simple: It could probably be understood and memorized by an average high-school student in a week. It is adaptable: It can use the most complex understanding of science without losing sight of measurable goals. It can unite contract law, torts law, criminal law, constitutional law, business law, property law, family law, etc. and help to eliminate contradictions between those fields of law. The concepts are universal: It can be used as a guideline to manage a nursery school, a family, a business, a war, or an empire. It is tested: It uses well defined, understood, and proven concepts of agreement, damages, risk, scientific method, predictability, compensation, etc. It is equitable: Those who benefit others reap rewards, those who risk detriment to others can be punished by paying compensation or by being gently restrained. It is egalitarian: It applies to all citizens, children, adults, leaders and criminals. It is highly flexible but gives no discretion for abuse: It has both positive law rules and exceptions but those exceptions are strictly measured. It is gentile: It seeks to maximize benefit and minimize damages to others in cooperation and correction. It is friendly: It ends "caveat emptor" (buyer beware) so it stops commerce from being predatory and creates a society where people are each other's agents to each other's benefit.

POSSIBLE OBJECTIONS TO THE SYMBIOTIC CODE AND RESPONSES

"It is too vague." The benefit of ideas which are less specific is that they can be more broadly applied. As an example, liability for the tort of negligence is simple because it is based on the four concepts of duty of care, breach of duty, actual and proximate causation of harm, and damages. (Prosser, 2005, p.132) This simple theory can be applied to all negligent actions of man from simple tripping over obstructions to actions as highly complex as medical malpractice.

"There are none of the many absolute rights as guaranteed in the bill of rights." This is because all rights are situational and society needs to adapt law to regulate action to the extent that an action will predictably cause greater damage than benefit in a previously unforeseen situation. As stated Supra, the Bill of Rights lists as absolute speech, bearing arms, freedom from searches, equal protection, etc. Yet virtually all these rights have been limited by government and often without clear reasoning. At least some of this reasoning for limiting constitutional rights is pragmatically justified. Pragmatism, however is not listed as an exception to rights in the Constitution. That the Supreme Court ignores the Constitution to reach these conclusions usurps the authority of the Constitution and leaves all rights dependent upon the pure discretion of the justices. Discretion is the opposite of law.

"It doesn't incorporate the ideal of democracy." Democracy is majority rule and therefore rule by discretion without adherence to governing principles. In democracy, a 51% majority can vote to unjustly enslave a 49% minority. Although democracy has served well to bring representation to government, the raw effect of democracy as a method of decision making is often unjust.

"It doesn't embrace the concept of liberty." Liberty is the right to do or not to do something. Whether, or to what extent, liberty is beneficial to an individual or a society depends upon the specific situation. As an example, suppose there was a public two-lane road which all citizens had a right to use. Suppose further that all citizens were restricted to driving on the right side of that road. Now imagine that a person challenged that law and wanted to drive on the left side of the road. While it is clear his pure liberty to use the road is cut in half by restricting him to the right side of the road for his travel, his and all other people's functional utility and safety would be greatly decreased by granting him the right to drive on the left side of the road. Liberty cannot be an absolute right in law.

"It doesn't incorporate the ideals of equality for all people." People are not equal, should not be treated as equals, and are not treated as equals. People can be correctly classified as superior, cooperative, subordinate, bad, or evil. It is absurdly inefficient to treat unequal people equally. For example, compare one person who is an evil psychopathic serial killer to another person who is an intelligent, caring governor of a state. The killer and the governor should have vastly different rights based on their apparent benefits and risks to society. We do not give the killer command of the state police and National Guard, nor do we lock the governor in prison for life.

"It doesn't state that government should serve all the people." Not all people should be served. Evil people should be efficiently restrained. People who are non-beneficial are not symbiotic and may be ejected from society.

"It doesn't guarantee property rights for those with wealth nor financial support to the poor." Property rights are not absolute but are used as a rebuttable presumption that rights in continued ownership are the most efficient. In situations where private ownership is clearly harmful it should be and is brushed aside. Here are two significant examples. First, suppose a person is driving and his car is stuck in a sudden violent snow storm. His only chance of survival is to break in to a vacant cabin for protection from the elements. Here the loss of real and private property rights are trumped by the importance of saving his life. Second, imagine there is a very intelligent young student from a poor family who would not otherwise be able to

afford to go to college to become a promising doctor. That society which takes money from tax payers to finance this student's college education will likely be paid back from the student directly and from his eventual much greater service to society as a doctor.

"The symbiotic code is too idealistic to overcome the establishment of an existing powerful and corrupt system." To the contrary, this code is designed upon the pragmatic ideal to assemble people into a symbiotic group and empower that group to be cooperatively competitive to displace traditional, combative, or corrupt legal systems. It can do that by providing widespread benefit, moral justification, and potentially massive rewards of wealth to those who assist in this effort. The 8th line of the code reads "to extract proportionate compensation from greater unearned benefits received," This means that the person, group, or corporation which usurps a corrupt system in a town, county, state, or nation, would have a claim to "proportionate compensation" from the efficiency gleaned displacing the corrupt or less efficient legal system. This reward could be millions of dollars for towns, billions of dollars for states, or trillions of dollars for national adoption of the code. The promise of massive profits, divided by reasonable risk, will buy an abundance of supporters enough to make the changes. A sequence of proselytizers, agitators, lobbyists, bribers, voters, coercers, and, if necessary, soldiers will be available.

LIMITATION OF THIS PAPER

This paper is written primarily for submission to The Science of Laws Institute. The author of this paper is trained in the structure and fundamentals of the Anglo-American legal system but is not a classically trained scientist or biologist. In apparent irony, the author is nonetheless advocating an edict to reform of the legal system by subordinating it to fundamentals of science and biology. If a fault of this paper is that some of the presumptions regarding psychology, historical anthropology, or biology are overly simplified, insufficiently cited, or vague, the paper may nonetheless suggest that the legal system is deficient and would benefit from scientific structure.

CONCLUSION

The conflicts of modern law are largely a result of a lack of scientific purpose and scientific methods for forming and reviewing laws. Observation will show that there can be a biological purpose to law which is cooperation of people for mutual benefit and reduction of risks. The methods of inducing allegiance to this code are rewarding those who can cause benefit and penalizing those who risk detriment to the symbiotic group.

FUTURE RESEARCH SUGGESTIONS

Whereas the legal system is not scientific, the process of amalgamation of law and science could probably benefit from interdisciplinary effort of jurists, biologists, scientists, engineers, and mangers in co-authoring future studies and papers.

The symbiotic code should be tested as a hypothesis on a small scale to see if it works for a club, business, or non-profit organization, or homeowner association. Based on successes, it should then be tested on a town or county government before being tested at the state and national level.

If laws and government are to follow the scientific method, it may be beneficial to make changes to the fundamental branches of government. Instead of a legislative, executive, and judicial branch, there may be similar observation, hypothesis, testing, and review branches. This difference is not as great as it sounds. The observation branch would be elite experts and academics to take the place of current congressional fact finding swayed by lobbyists and other political considerations. The observation branch would be independent but would report their findings to the hypothesis branch for legislation. The hypothesis branch would be handled much the same as the former legislative branch but the laws would be phrased tentatively and not continue indefinitely without being regularly reviewed for effectiveness. The testing branch would essentially do exactly what the executive branch did before. The review branch would be a combination of courts to protect personal interests and generalized research regarding effectiveness and side effect of laws. The review branch would report their findings to the observation branch where the process would start again if necessary.

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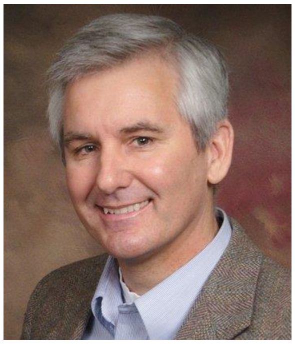

Peter Wallis was very patriotic from his youth and joined the U.S. army to become an infantryman when he was 18 years old. He was stationed in Europe, became a paratrooper, and later studied and received a degree in foreign language. Peter then studied international relations at San Francisco State University. He became a successful small business owner in New York and later became a successful real estate broker in New Mexico where he became active in the Libertarian Party. Peter Wallis became a political activist when he filed a nationally famous lawsuit challenging fundamental family law principles for which he has been interviewed by national and international newspapers, radio, and television. He has also helped to write and lobby state bills to reform criminal and family law. At the age of 48, Peter returned to school and in 2015 received a J.D. from Northwestern California University School of Law.

PROCEEDING

System Dynamics Structures for Modeling Lawmaking Processes

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ABSTRACT

Modeling and simulation can help improve lawmaking processes. 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. Structures for modeling these processes are provided as reusable building blocks. These structures and their behaviors are process patterns that frequently occur. Examples are shown assembling these recurring structures into larger models demonstrating behavior patterns of lawmaking processes including feedback loops. The behaviors are visualized as process trends over time.

This paper overviews: 1) basic system dynamics elements and their applied instances in lawmaking, 2) generic flow processes which are small microstructures comprised of a few elements serving as modeling molecules with characteristic behaviors, 3) infrastructures composed of several microstructures producing more complex behaviors, 4) flow chains which are infrastructures consisting of a sequence of levels and rates (stocks and flows) that are model portion backbones, and 5) introductory examples of lawmaking process structures.

Even small system dynamics models have been shown useful for understanding complex public policy issues, and thus well suited to assess specific laws and/or aspects of local, national and international lawmaking processes. The structures and applied examples are provided as open source models for the community to incorporate, adapt and apply for lawmaking.

Keywords: Lawmaking Processes, System Dynamics, Modeling and Simulation

INTRODUCTION AND BACKGROUND

A scientific approach to lawmaking has the potential to improve the efficiency of lawmaking processes, and the effectiveness of laws created. Modeling and simulation can be used for these purposes.

Applying science to lawmaking was proposed by Schrunk because traditional methods haven't produced laws that consistently solve societal problems (Schrunk, 2005). Modeling and simulation are successfully applied across many disparate fields to gain better process understanding, and lawmaking is a fruitful area for investigation.

This work applies simulation concepts to create model structures that can be used to 1) evaluate the lawmaking process, i.e. the steps taken to create laws including their order, and 2) assess laws before implementation on how well they will meet their goals and compare options. The latter consideration includes all intended and unintended consequences of law implementation.

System dynamics was developed by Forrester to improve organizational structures and processes (Forrester, 1968), from which this work is ultimately derived. It has been applied across numerous fields and is a commonly used method for modeling continuous systems.

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Many system dynamics applications have been developed which could be adapted for lawmaking processes. However, the modeling task may be difficult and time consuming for new or even experienced modelers.

This work helps fill the knowledge gap for the lawmaking domain, and make the modeling easier. 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 taxonomy and process representations provide generalized and adaptable "plug and play" components of varying complexity to build lawmaking process models.

The structures and their behaviors are process patterns that frequently occur. The recurring structures are model "building blocks" that can be reused. They provide a framework for understanding, modifying and creating system dynamics models regardless of experience. With access to reusable formulations that have been repeatedly proven, previous work can be understood easier and the structures incorporated into new models with minimal modification.

Previous work for classifying system dynamic structures was been done in (Hines, 2000), where relatively small scale generic "modeling molecules" are described. Simulation packages often come with usage examples, such as (Richmond et al., 1990) which provides descriptions of common building blocks. Other work that has provided a comprehensive modeling taxonomy for a specific domain is in (Madachy, 2008) for software development processes.

A written law is a piece of code that requires internal consistency and completeness to meet the law's purpose(s). Thus laws are very similar to software. It is found that many modeling structures for software development processes have strong analogies in the lawmaking process domain.

SYSTEM DYNAMICS OVERVIEW

System dynamics provides a very rich modeling environment. It can incorporate many formulations including equations, graphs, tabular data or otherwise. Models are formulated using continuous quantities interconnected in loops of information feedback and circular causality. The quantities are expressed as levels (also stocks or accumulations), rates (also called flows) and information links representing the feedback loops. See Appendix A for the underlying mathematical formulation.

The system dynamics approach involves the following concepts:

– defining problems dynamically, in terms of graphs over time

– striving for an endogenous ("caused within") 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, which was Forrester's overall goal.

A major principle is that the dynamic behavior of a system is a consequence of its own structure. Given this, the structure of a system can be focused on in order to effect different behavior. Improvement of a process thus entails an understanding and modification of its structure. The structures of the as-is and to-be processes are represented in models.

The existence of process feedback is another underlying principle. Elements of a system dynamics model can interact through feedback loops, where a change in one variable affects other variables over time, which in turn affects the original variable. Understanding and taking advantage of feedback effects can provide high leverage.

Below is an overview of terminology related to system dynamics model structures and behavior:

Elements are the smallest individual pieces in a system dynamics model: levels, rates, sources/sinks, auxiliaries and information connections. See Figure 1 for their visualizations.

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.

This paper does not explicitly discuss archetypes in detail. They present lessons learned from dynamic systems with specific structure that produces characteristic modes of behavior. The structures and their resultant dynamic behaviors are also called patterns. Whereas molecules and larger structures are the model building blocks, archetypes interpret the generic structures and draw dynamic lessons from them. Senge discusses organizational archetypes based on simple causal loop diagrams in The Fifth Discipline (Senge, 1990).

MODEL STRUCTURES AND BEHAVIORS

Next is a review of the basic model elements, generic flows and infrastructures. Specific structures for law-making process models and some behavioral examples will be identified. All of the lawmaking process structures are derived from one or more generic structures. Each structure can be represented with a diagram, summary of critical equations, and behavioral output.

The generic flow processes, infrastructures and behaviors are extensive and thorough. Due to space limitations only a few are illustrated for simple lawmaking processes. This paper will instead present important flow chains to use for model backbones as partially filled skeletons. The reader is encouraged to read supplemental traditional references on the smaller general structures for system dynamics (Forrester, 1968), (Hines, 2000), (Madachy, 2008), (Sterman, 2000).

MODEL ELEMENTS FOR LAWMAKING

The basic elements of system dynamics models are levels, flows, sources/sinks, auxiliaries and connectors or feedback loops. Figure 1 serves as a legend showing the standard notation of these elements in a rate and level system with an auxiliary variable connected to the rate via an information link. Next the standard elements are briefly reviewed with example instantiations for lawmaking processes.

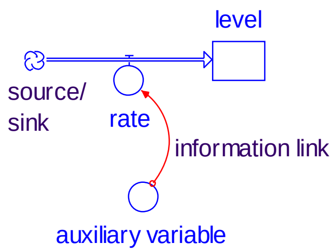


Figure 1. Model Notation of a Rate and Level System

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. These major level types are detailed further per the following:

- 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 (see example flow chains in the Lawmaking Process Chain Infrastructures section).

- 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.

Level examples may also include quantities such as effort and cost expenditures, fines levied or paid, case schedule dates, personnel attributes such as motivation, staff exhaustion or burnout levels, law amendments and law drafting errors.

There could be many application-specific level types based on the purpose and context of modeled laws. For example, modeling the dynamics of illicit drug laws may entail drug demand levels, the number of cartels, or agricultural resource levels of cartels as demonstrated in (Olaya and Angel, 2014).

When the intent of a regulatory law is to prevent bodily injury or harm, then evaluating its effectiveness may necessitate modeling injuries, deaths, hospital stays, health costs incurred, etc.

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.

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. Examples 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.

GENERIC FLOW PROCESSES

Generic flow processes are the smallest, essential structures based on a rate/level system that model common situations and produce characteristic behaviors. They consist of levels, flows, sources/sinks, auxiliaries and sometimes feedback loops.

See the following summaries of generic flows and example applications. Equations are shown for the cases where relations exist with other variables that drive characteristic behavior patterns.

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. See Figure 2. 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.

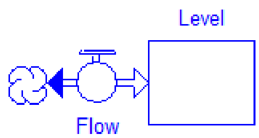


Figure 2. Rate and Level System

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. See Figure 3. 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.

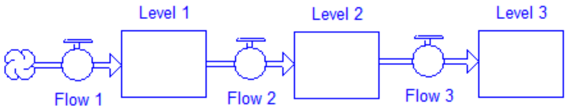
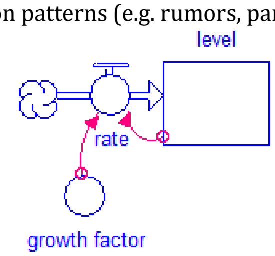


Figure 3. Flow Chain with Multiple Rates and Levels

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. See Figure 4. 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.

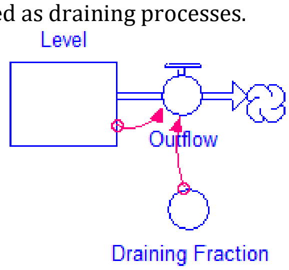


Rate = Level * Growth Factor

Figure 4. Compounding Process

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. See Figure 5. Draining is a common process that underlies delays and exponential decays. Case promotions, fine payments, personnel retirement, skill loss and many other trends can be modeled as draining processes.

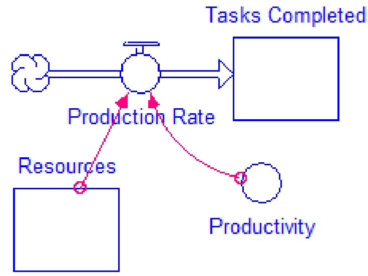


Outflow = Level * Draining Fraction

Figure 5. Draining Process

Production Process

A production process represents work accomplished at a rate equal to the number of applied resources multiplied by the resource productivity. See Figure 6. 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.

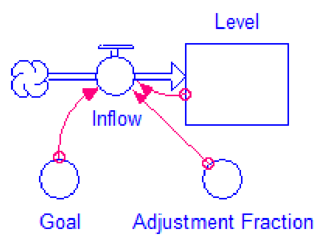


Production Rate = Resources * Productivity

Figure 6. Production Process

Adjustment Process

An adjustment process is an approach towards goals or equilibrium. The structure contains a goal variable, a rate, level, and adjusting parameter. See Figure 7. 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

Figure 7. Adjustment Process

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 another host flow rate, and normally has a conversion parameter between them. See Figure 8. 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.

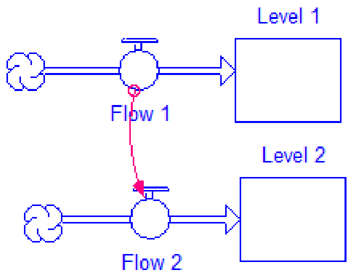


Figure 8. Co-Flow Process

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. See Figure 9. 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.

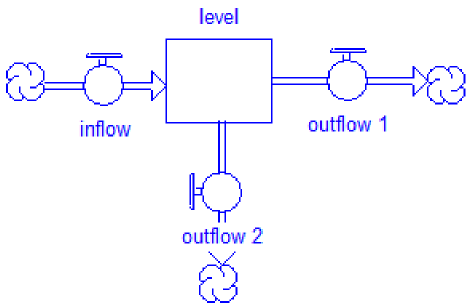


Figure 9. Split Flow Process

Cyclic Loop

A cyclic loop represents entities flowing back through a loop. See Figure 10. 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.

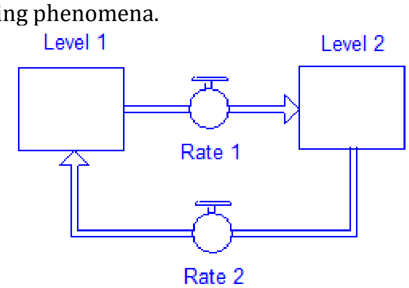


Figure 10. Cyclic Loop

EXAMPLE GENERIC FLOWS

Figure 11 shows an example of a basic production structure applied to lawmaking. This structure associates multiple personnel resource levels with bill production. It starts with a number of bills to be written, and the bill writing rate uses the number of applied resources (the legislative staff sizes) multiplied by their respective productivities adjusted for experience levels. The staff transition through the experience levels with an average assimilation time and the overall productivity is affected.

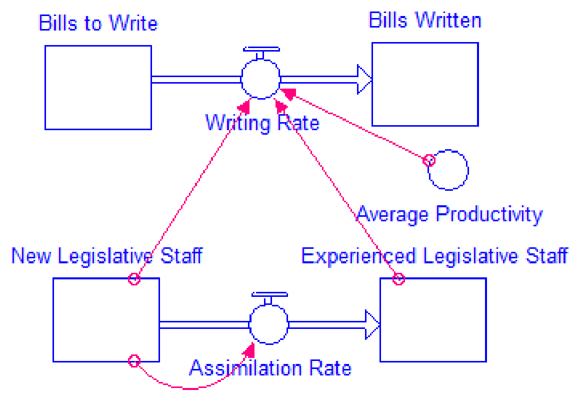


Figure 11. Example Legislative Production Structure

The productivity of legislation could be measured with different units. Traditionally it is bills per time unit as this example, but a more normalized "product" could be bill pages to account for different size bills. Example empirical data on the bills/year and bill pages/year for U.S. Congress per (GovTrack, 2016) could be used to calibrate or validate productivity models.

Figure 12 shows an example split flow process for crime detection. This generic flow could be part of a larger model for the laws and enforcement levels that affect crime detection efficiency and the initial commitment rates. The detected crimes could flow into another model portion for the prosecution aspects.

This structure allows policy analysis in terms of setting punishment levels for the deterrence factor. The resources expended on crime detection can also be varied.

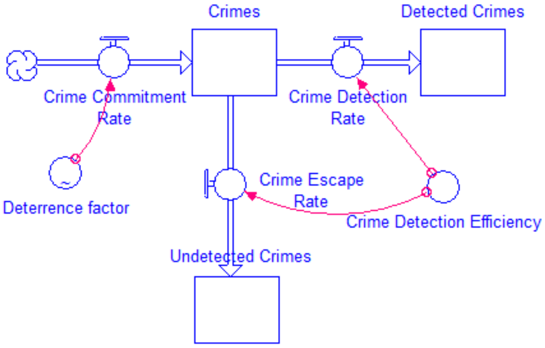


Figure 12. Example Crime Detection Model Structure

INFRASTRUCTURES AND BEHAVIORS

The infrastructures in Table 1 are based on one or more of the generic flow types with additional structural details. The additional structure typically leads to characteristic dynamic behaviors. A few of the structures herein do not cause specific dynamic behaviors, but instead are used for intermediate calculations, converters or instrumentation of some kind.

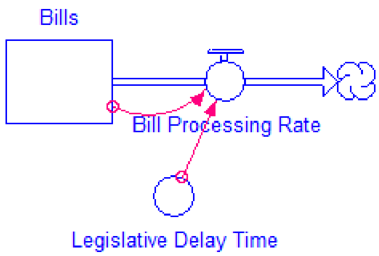
Decision structures are often represented within these structures. These may include policies to allocate legal staff, adjust legal policy goals as enforcement progresses, case turnaround policies, etc. Goals may include desired bill turnaround times, crime or injury reductions, etc.

Table 1. Example Infrastructures and Behaviors with Examples

Infrastructure	Description and Examples
Exponential Growth	Growth structures are based on the generic compounding flow process. Examples are legal paperwork escalation or new crime markets (see the compounding process).
S-shaped Growt and S-curves	An S-shaped growth structure contains at least one level, provisions for a dynamic trend that rises and another that falls. There are various representations because S-curves may result from several types of process structures representing the rise and fall trends. Examples are cumulative cost to establish new laws or enforcement knowledge diffusion. Deterrence against penalty levels exhibits the diminishing returns in S-curves.
Delays	Delays are based on the generic draining process. A classic example is the time delay to try a case. Exponential decay results when the outflow constant represents a time constant from a level that has no inflows. The decay declines exponentially towards zero. A higher order delay behaves like a connected series of first order delays.
Balancing Feedback	Balancing feedback (also called negative feedback) occurs when a system is trying to attain a goal, such as a minimum threshold of injuries via regulation or an enforcement hiring goal.
Oscillation	Oscillating behavior may result when there are at least two levels in a system. Normally there is a parameter for a target goal that the system is trying to reach, and the system is unstable as it tries to attain the goal. Goals may represent desired law effects or resources levels. Examples are oscillating crime rates or personnel systems
Smoothing	An averaging over time. Random spikes will be eliminated when trends are averaged over a sufficient time period. Examples are perceived safety from crime or opportunity for it from the criminal perspective.
Integrated Production Structure	This infrastructure combines elements of the task production and human resources personnel chains. Production is constrained by both productivity and the applied personnel resources external to the product chain. The level of personnel available is multiplied by a productivity rate.
Learning Curve	The continuously varying effect of learning can be modeled via a classic feedback loop between the completed tasks and productivity, to account for becoming more proficient at a legal task. It occurs on individual and organizational levels.
Attribute Tracking	Important attributes to track are frequently calculated from levels. They can be used as inputs to other model portions, such as a decision structure. For example, normalized incarceration rate is calculated by dividing incarcerations by the total population size.
Attribute Averaging	A structure for attribute averaging (similar to attribute tracking) calculates a weighted average of an attribute associated with two or more levels.
Effort Expenditure Instrumentation	Effort or cost expenditures are co-flows that can be used whenever effort or labor cost is a consideration. Frequently this structure serves as instrumentation to obtain cumulative effort and does not play a role in the dynamics of the system. It could be used for decision making in actual processes or measuring cost for comparative purposes.
Decision Structures	Infrastructures for decision policies frequently determine rates. Some common decision structures relevant to lawmaking processes include desired enforcement staff, legal resource allocation, or scheduled case completion date

EXAMPLE INFRASTRUCTURES AND BEHAVIORS

An example structure for a first order delay is shown in Figure 13 that models outflow from a level as introduced in Table 2. It models a batch of bills to process with a time delay. The resulting behavior is in Figure 14. The equation expresses the bill processing outflow rate as a function of the bill level and average legislative delay time. It produces the characteristic exponential decline shown in Figure 14 for a starting level of 10 bills and average delay time of 90 days. This is a simplified example doesn't account for new bills coming in, but the same structure is used when an inflow rate is attached to the initial bill level.



Bill Processing Rate = Bills / Legislative Delay Time

Figure 13. Example Delay Structure for Bill Legislation

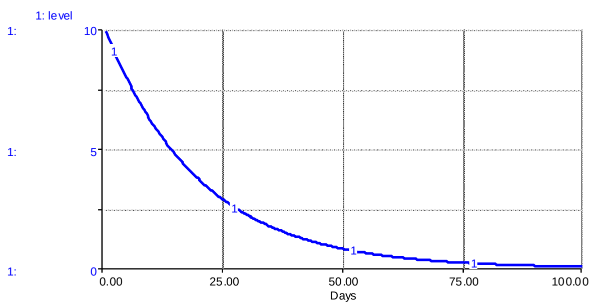


Figure 14. Example First Order Delay Behavior

Figure 15 shows an information smoothing infrastructure modeling perceived crime opportunity as short intermittent interdictions are held. The behavior is in Figure 16. Opportunity is the degree to which criminals feel safe to commit crimes without being caught. When interdiction occurs it takes a delay time to adjust their perception afterwards. The policy implications for lawmaking are the interdiction timing and force levels with limited resources.

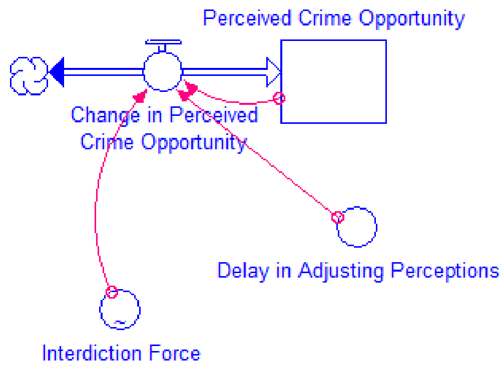


Figure 15. Example Information Smoothing Structure for Crime Opportunity

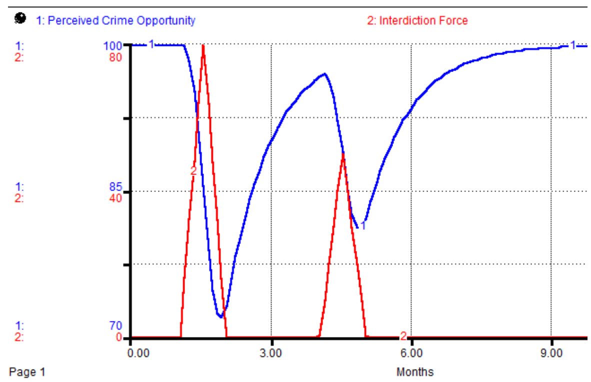


Figure 16. Example Information Smoothing Behavior

Figure 17 shows an example oscillating system demonstrating the cycles of criminals and continuous security forces seen in Figure 18. This example is based on a predator-prey model. The oscillation derives from the cat-and-mouse dynamics between the two levels of continuously embedded security and criminal populations.

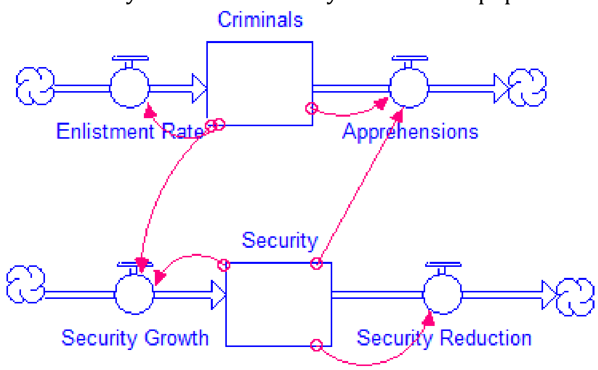


Figure 17. Example Oscillating Structure for Criminal and Security Populations

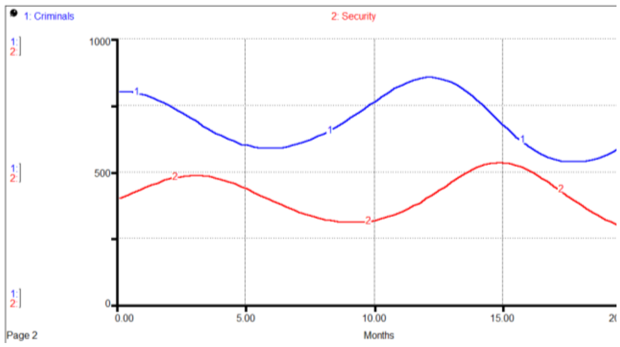


Figure 18. Example Oscillating Behavior

EXAMPLE FLOW CHAIN INFRASTRUCTURES

This section identifies flow chain infrastructures related to lawmaking processes consisting mostly of cascaded levels for legal artifacts, infractions and people. These infrastructures can be used as pieces in a comprehensive lawmaking process model, or could serve as standalone base structures for isolated experimentation.

The chains represent basic flows pervasive in lawmaking processes. When applying system dynamics, the question must be asked: What is flowing? Determination of what kinds of entities flow through a lawmaking process is of primary importance to identify the chains to build models on top of. As always when modeling with system dynamics, the level of aggregation used in the chains depend on the modeling goals and desired level of process visibility.

Laws become transformation sequences modeled as conserved flows, where each level has the same unit, or in non-conserved flow chains where transformation steps are modeled using distinct artifact types for the stages of new legislation. Each level has different units in non-conserved chains. If the lawmaking modeling goals dictate that sequential legislation artifacts be modeled in their respective units then non-conserved flows are used.

Violations include crimes or infringements resulting in jail time, fines or suits to settle. Violation counts are an important law process measure that can provide many insights on law efficiencies and dynamics. There are a number of ways to represent infractions including their generation, detection and case resolutions. Infractions are the primary focus in the chains, but are inextricably tied to other aspects such as law production, enforcement practices, etc.

People flows are conserved flow chains traditionally accounting for sequential experience or promotion pools. Chains for personnel are mainstays of models to account for legal labor and may correspond to attributes for different skillsets, or other differentiators requiring more detail than auxiliaries or single levels can provide. Frequently the chains contain two or more experience levels (e.g. rookies vs. experienced policemen). Varying degrees of detail and enhancements are possible, such as adding chain splits for attrition from any experience level.

Some introductory examples of flow chains are provided as illustrations. A top-level example of a standard process for lawmaking is in Figure 19. It shows the different stages of laws from enacted to repealed. The flow chain houses many laws moving through their states and they accumulate in the levels. The number of laws in any level could be counted at a given instant of time. Not shown is the external bill introduction process before they are made laws (as in Figure 20 following).

The lawmaking flow chain is a skeleton that could be augmented with additional detail of relationships. For example, the delay structure in Figure 3 for legislative delay could be a component of such a flow chain.

An example of a flow chain for a state legislative process for a house is in Figure 20. This example is modeled after the California processes for the Senate and Assembly (State of California, 2016). It is simplified by not showing the possible iterations of committee amendments. This process would be repeated in both houses and then requires final resolutions of differences and the Governor's signature (not shown). It could be augmented with the actual observed delays, bill introduction rates and other representative rate patterns.

Figure 21 models a common criminal justice process flow. Not shown are possible separate flows for felonies and misdemeanors, and additional activities beyond the boundary for penitentiary and parole states. The rates and levels could be expanded for these additional considerations.

Figure 22 shows a flow chain infrastructure for Intellectual Property Rights (IPRs) modified from (Derwisch and Kopainsky, 2010). It shows the states of IPRs from initial application through court cases for infringement. It is not assumed that all IPRs go through each level, and some may traverse no further than the middle levels.

The added detail on this infrastructure shows some nearest neighbor variables affecting the rates. Not included are the other connections relating the variables. This example illustrates how the basic infrastructures can be incrementally built out with supporting detail.

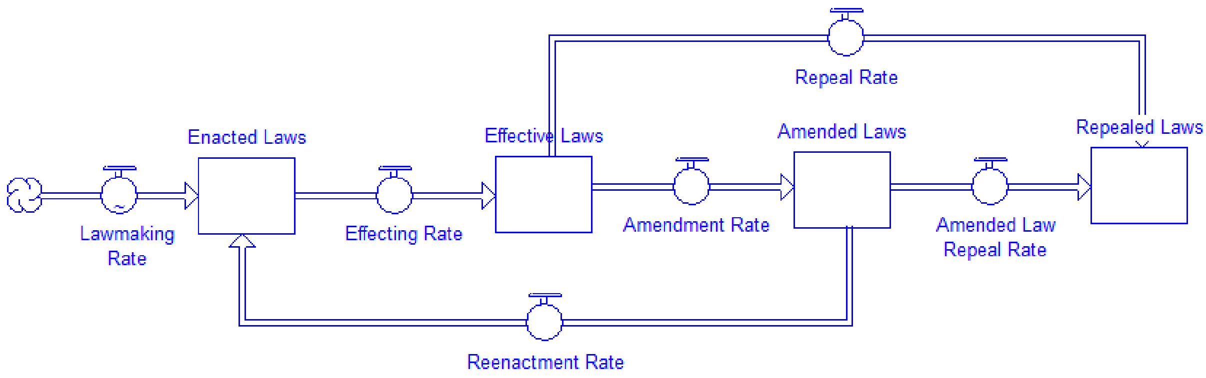


Figure 19. Lawmaking Flow Chain

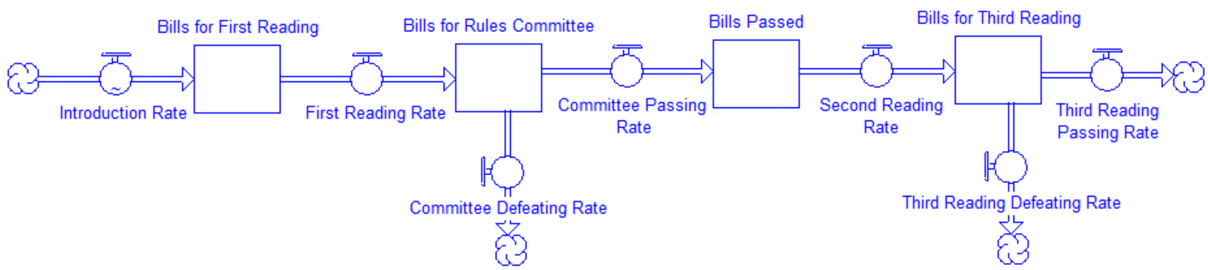


Figure 20. State Legislative Process Flow Chain

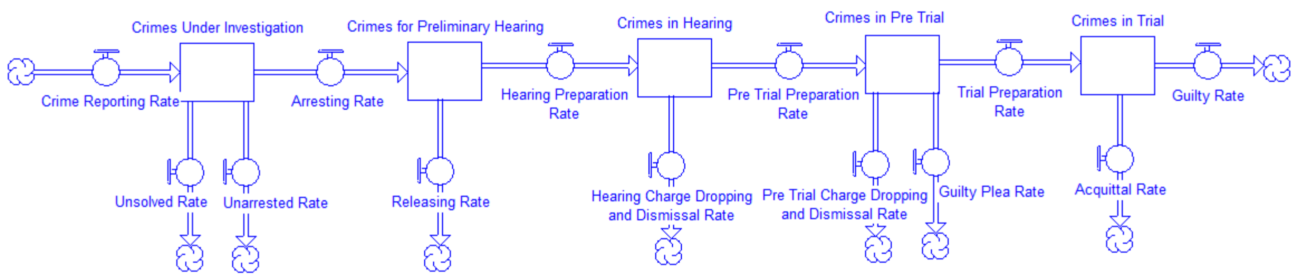


Figure 21. Criminal Justice Process Flow Chain

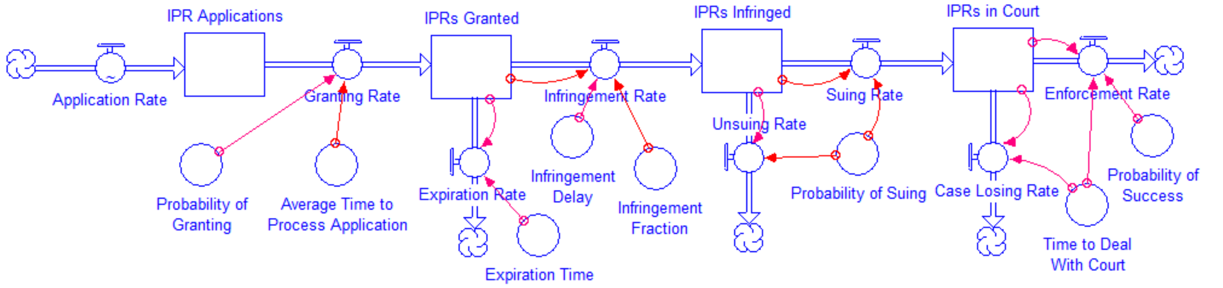


Figure 22: Intellectual Property Rights (IPR) Process Flow Chain with Added Detail

CONCLUSIONS AND FUTURE WORK

This work provides reusable model structures interpreted and tailored for the lawmaking process domain. The hierarchy of model structures and patterns provides a taxonomy for lawmaking applications. Characteristic behavior patterns over time are encapsulated with their causal structures.

The reusable model assets have been the result of culling lawmaking and related processes and are convenient for creating new model applications. Lawmaking personnel, electees or officials in legislative and regulatory bodies, legal scholars, public policy researchers, other legal practitioners and students are encouraged to use and experiment with them.

Modelers can save time by leveraging existing and well-known patterns. The generic structures are starting templates that can be combined in different ways, and with detail added to create larger infrastructures and complex models. The building blocks help lower the barrier of adoption in the community because they can be quickly reused and adapted for numerous applications.

This author will continue improving these modeling assets, developing fuller models for specific investigations and seeking actual data to support the modeling. The generic structures, sample flow chains and models will be provided in the public domain.

Subsequent work will include small scale models demonstrating system archetypes in lawmaking, such as showing how unintended consequences of laws occur. More elaborated, complete model applications will also be provided. Web-based, executable versions will be accessible for public usage of the lawmaking applications.

This author is collaborating with the Science of Laws Institute to provide public models and resources. Readers can check http://www.scienceoflaws.org/models or http://sdsim.com/models/lawmaking and we invite your feedback and suggestions.

Further detailed investigations into IPR laws are underway (adapting Figure 22). This will be reported in subsequent work with a focus on software intellectual property. The modeling has some commonalities with (Derwisch et al., 2010) on IPR dynamics and (Bodner, 2015) for international aspects.

Empirical data collection for developing and validating lawmaking models will also be undertaken. Actual data on all aspects of lawmaking is critical, and must be continuously sought for solid model underpinnings.

Public records can provide much data on legislation and its impacts. For example, data on the U.S. Congress bill passage rate for the last few decades (GovTrack, 2016) provides actual rates of bill passages, bill page sizes, etc. in order to calibrate such models. Crime and incarceration statistics are readily available. But there is also data hidden or held "close to the vest" for some legislative processes where more transparency is needed.

This paper is a beginning as there are numerous law topics to investigate aided by simulation. It is hoped to catalyze interest in the field, and provide guidance on one approach for applying science for better lawmaking.

The application gamut spans local, national and international legislative processes. Thousands of specific laws (current and proposed) warrant detailed study and analysis. High-level models can also be developed for the lawmaking trade space. For example, trying to determine the "sweet spot" of the optimal number of laws as a societal risk balance.

The models are for insight and impact, not just for play. The goal is to interject use of models and simulation into actual legislative practice. Eventually we hope that modeling and simulation of lawmaking will become adopted as an inherent part of the process and standard professional practice.

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APPENDIX A: MATHEMATICAL FORMULATION OF SYSTEM DYNAMICS

The mathematical structure of a system dynamics simulation model is a set of coupled, nonlinear, first-order differential equations,

$$\mathbf{x}'(t) = \mathbf{f}(\mathbf{x},\mathbf{p}),$$

where **x** is a vector of levels, **p** a set of parameters and **f** is a nonlinear vector-valued function. As simulation time advances, all rates are evaluated and integrated to compute the current levels.

Runge-Kutta or Euler's numerical integration methods are

$$Level = Level_0 + \int_0^t (\text{inflow} - \text{outflow})\, dt$$

normally used for determining levels at any time *t* based on their inflow and outflow rates:

The *dt* parameter corresponds to the chosen time increment for execution. Corresponding system dynamics code for the level calculations would be:

Level(time) = *Level*(time-dt) + (*inflow* - *outflow*)*dt

INIT $Level{=}Level_0$

where *Level* is computed for any time, $Level_0$ is the initial level value, and the flow rates to/from the level are *inflow* and *outflow* respectively. Describing the system with equations like the above spares the modeler from integration mechanics.

Note that tools relieve the modeler from constructing the equations; rather a diagrammatic representation is drawn and the underlying equations are automatically produced.

Dr. Raymond Madachy is an Associate Professor in the Systems Engineering Department at the Naval Postgraduate School. His research interests include system and software cost modeling, affordability and tradespace analysis, modeling and simulation of systems and software engineering and lawmaking processes, integrating systems engineering and software engineering disciplines, software litigation and intellectual property rights. Previously he was a Research Assistant Professor in the Industrial and Systems Department at the University of Southern California and a Principal in the USC Center for Systems and Software Engineering. He has over 90 publications including the book *Software Process Dynamics*, is a co-author of *Software Cost Estimation with COCOMO II* and *Software Cost Estimation Metrics Manual for Defense Systems*. He is currently writing *Systems Engineering Principles for Software Engineers*.

PERSPECTIVE

The Role of Systems Engineers in Lawmaking

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EDITOR'S NOTE: The following is an article written for and originally published in the International Council on Systems Engineering's San Diego Chapter Newsletter.

The laws of government (such as statutes, regulations, and ordinances) are the primary means by which the problem-solving goals of government are attained. Unfortunately, the traditional method of lawmaking is critically flawed. As a result, societal problems (including crime, poverty, and financial instability) remain largely unsolved, and governments thus fail to satisfy their public benefit purpose. Fortunately, a solution to this problem has been proposed: expand science to encompass laws and the lawmaking process.

All established fields of science are successful as measured by the continuous accumulation of reliable (i.e., scientific) knowledge and by continual technological advances (i.e., engineering). Lawmaking should not be an exception; however, such successes cannot be achieved without dedicated professionals consistently striving to better their field. In the case of lawmaking, these professionals are systems engineers who must consistently balance a plethora of distinct and sometimes conflicting desires from a variety of stakeholders in order to design laws and bodies of laws that operate in an effective, cost-efficient, and safe manner to collectively benefit the general public.

The present state of laws and lawmaking, which largely lacks the influence of systems engineers, suffers from two major issues. First, the traditional legislative process is not a problem-solving process. It is merely a lawmaking process that lacks the essential steps (e.g., problem definition, requirements prioritization, cost-risk-benefit analyses, etc.) required to solve problems. Second, governments typically lack a consistent mechanism for the measurement, evaluation, and documentation of the effects of laws (both intended and unintended). As a result, governments are essentially "flying blind" in the creation and sustainment of laws. In other words, they create and enforce laws but have no reliable means to then determine the impact of those laws on the general public they are intended to serve. The results of these deficiencies are inconsistent and incidental successes insolving or mitigating societal problems combined with an ever-growing, and increasingly burdensome, body of laws.

The introduction of systems engineers and systems engineering principles to lawmaking will solve the aforementioned deficiencies. Systems engineers are trained in and adept at solving problems. They will be able seek out the root-cause of the identified issue and immerse themselves in the context of the problem. They will work with a myriad of stakeholders to understand their perspectives, needs, and desires as they design laws that best benefit the general public. Further, systems engineers are trained in and adept at identifying and understanding system interactions and emergent properties. As such, systems engineers will be capable of understanding and managing the system-level properties exhibited by a complex and dynamically interacting body of laws.

Another common skill among systems engineers is their ability to develop processes that produce consistent results. Systems engineers can apply this skill to develop a quality assurance program for laws. With knowledge gained from the scientific observation of laws, this quality program will be able to determine the degree to which laws are satisfying their intended purpose, the financial cost of the law, and additional effects of the law (whether intended or unintended). Then, the administrators of this process will be able to recommend whether laws should remain on the books, be modified to address a measured deficiency, be removed due to the fact the law is ineffective, or be retired after successfully addressing the original problem or goal. Through the execution of this program designed by systems engineers, the quantity of laws will be reduced. This reduction in laws will then allow governments to invest their finite resources on the remaining laws that are shown to be both effective and cost-efficient.

Many industries are reaping the rewards of applying systems engineering principles. These rewards include improved safety, reduced cost, and increased effectiveness. Further, these industries experience a sustained rate of advancement where each new version or iteration is able to provide better results than one it replaced. It is therefore predictable that applying systems engineering principles to lawmaking will produce similar results. While predictable, these results would be nonetheless astounding. Just imagine governments consistently satisfying their public benefit obligations through laws that are created by engineering design methodologies and managed by an equally well-designed quality assurance program. Next, imagine you, the systems engineer, playing a critical role in

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that process.

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