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ELECTION SEASON

Imagine, if you will, a society that built a fabulous flying machine and every four years this society elects a pilot. Some members of this society argue that a pilot with a disciplined military background is necessary. Other members firmly believe a pilot who has flown passenger aircraft relates better to the people. Yet another section of the society is convinced that pilots with cargo backgrounds are business-minded and get things done in a no-nonsense manner. Throughout its history, this society has elected pilots with each of these backgrounds. Some pilots were absolutely fantastic and are a proud part of this society's history. Other pilots crashed the flying machine and caused great damage. Yet the majority of pilots, regardless of their background, had the same outcomes. They started off shaky, but they eventually got the flying machine airborne for a short duration and then landed not far from where they took off. Pilot after pilot, the results were mostly predictable. The society grumbled about the amount of money they spent on the flying machine and the lack of progress it has made. These frustrations grew especially large during the election season as everyone knew the flying machine's progress depended on the abilities of the pilot.

One election season, an elder had an epiphany! He ran about town telling anyone who would listen that while a good pilot was indeed necessary, true progress could only happen if they modified the flying machine. Many people were naturally skeptical. First, this flying machine had been around for decades and people knew it could fly well. In fact, there were historical examples that proved this; however, they were rare. Second, the people would need the pilot's permission to modify the flying machine and no one believed a pilot would have any interest in changing the design. Despite the skepticism, the elder did not give up. Rather, he assembled a team of scientists and engineers who studied aircraft design, modeled different design changes, and measured real life experiences. Eventually, they had enough facts and momentum to begin applying their science to the actual flying machine. Guess what happened? Each year the machine flew farther, every newly elected pilot was able to achieve results better than the previous one, and the society was prouder than ever of their achievements.

As we in the United States prepare to elect our next "pilot," many will rightly argue that certain qualities make some candidates better than others. Yet, we should not be so focused on the pilot that we fail to include in the dialogue the much needed debate on the "aircraft" itself. For it is the design of the laws our President is entrusted to execute that will have an even greater impact on the progress our nation will achieve in the coming years. It is time to focus on the Science of Laws!

–John Wood, Editor

The Taxonomy of Scientific Lawmaking

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ABSTRACT

The science of laws is a new science that was created by the expansion of science to encompass laws of government and the lawmaking process. The promise of the science of laws is that it will enable governments to satisfy their public service obligations through the rule of law. The present paper discusses the principles, structure and operation of the science of laws.

INTRODUCTION

A system of governance that provides a rule of law is essential for the stability of every social organization. Without a rule of law that stipulates and enforces the rights and obligations of individuals and institutions, a modern complex society could not exist: there would be no guarantee of individual rights and no security of person or property. Governments therefore create and enforce bodies of laws in an attempt to maintain a stable societal order.

TRADITIONAL LAWMAKING

Governments, past and present, have relied upon the traditional method of lawmaking, which is based on opinion, rhetoric and dialectic, to create laws. The traditional method has been successful in the production of large bodies of laws but it has not been successful in the solution of societal problems [1, 2]. Despite the continued output of laws by legislative assemblies and the resultant expenditure of resources, high rates of crime, illiteracy, poverty, and homelessness, etc., continue to plague many societies. For authoritarian governments, whose purpose is to control people (the subject class of people) for the benefit of the rulers of government (the ruling class), the inability of the traditional method of lawmaking to solve societal problems is an acceptable outcome (see discussion of authoritarian governments, reference 1).   In contrast, the purpose of democratic governments is to secure the rights and liberty of their citizenry – the people as a whole [3]. Since governments operate by means of laws, the purpose of laws in a democracy is to solve the societal problems that degrade or threaten to degrade the rights and liberty of the citizenry. Thus, for democracies, the failure of the traditional method of lawmaking to solve societal problems is an unacceptable outcome.

THE SCIENCE OF LAWS

To correct the deficiencies of the traditional method of lawmaking, a new science, the science of laws, was created in 1996 by the Science of Laws Institute [2]. The new science will increase the body of reliable (scientific) knowledge of laws of government and the lawmaking process, and of related knowledge-gathering and law-design methodologies. As the science of laws grows and as law-design expertise improves, governments will eventually be able to create bodies of laws that solve societal problems in a manner that optimally serves the purpose of democracy.

The concept of a science of laws has been discussed in the past [4, 5, 6] but there had been no known formal action to create an operational science of laws prior to 1996. The new science of laws consists of a society of peers that sponsors regular scientific symposia, publishes reports of scientific studies in the peer-reviewed Journal of the Science of Laws, and maintains a data base of abstracts of literature that are relevant to the science of laws. In the conduct of investigations and procedures, the science of laws observes the highest standards of the ethos of science [7]. The science of laws is divided into two co-equal branches: The Investigative Science of Laws and The Creative Science of Laws.

Investigative Science of Laws: The investigative science of laws is the "exploration and discovery" branch that uses the scientific process to derive and report, in the peer-reviewed scientific literature, reliable knowledge of the mechanics ("cause and effects") of laws and of methodologies for the measurement and analysis of laws. The investigative science of laws regards every law of government to be an experiment of human behavior. Every law has a hypothesis (that it will produce a desired societal outcome) and the hypothesis is tested (i.e., the experiment is carried out) when the law is enforced.   A serious flaw of the traditional method of lawmaking it that it does not measure or analyze the outcome of laws – and some laws may be doing harm to the citizenry in violation of the purpose of democracy. In other words, the traditional method of lawmaking begins law-experiments but does not complete them.

The investigative science of laws completes the "experiment" of laws by measuring and analyzing the results

of law enforcement, thus deriving reliable knowledge of the mechanics of laws. With the accumulation of knowledge of outcomes, governments can repeal non-productive laws and law design engineers can create more effective and just laws while avoiding the mistakes of the failed laws of the past.

The results of scientific examinations of both individual laws and systems of laws will be reported in the peer reviewed scientific literature so that the growing body of reliable knowledge of laws will become available to the scientific community, governments, and the public. Since laws are the problem-solving means, or tools of government, the classification system of scientific reports of a given law (or of a system of laws) is based upon the category of societal problem (e.g., crime, poverty, pollution, war…) that the law addresses. One significant benefit of the investigative science of laws is that it will enable the development of a quality assurance (QA) program of laws.

Quality Assurance of Laws: Unless a government measures the outcomes of its laws, it is "flying blind." That is, a government cannot know if it has accomplished anything of value for the public unless it utilizes a quality assurance (QA) feedback program to assess the outcomes of law enforcement. A science-based QA program for laws will evaluate the performance of each law periodically (e.g., every ten years). It will measure, analyze, and document the problem-solving outcome of each law, including its costs and other burdens, and its impact upon the human rights, living standards, and quality of life of the public. A determination of the performance of each law and its net benefit to the public will then be made (the net benefit of a law is the difference between the problem-solving benefit of the law and the sum of its costs, risks, restrictions, and other burdens). If the QA program determines that the net benefit of a law is positive, the law will be referred to the legislature for affirmation and continued enforcement. If the measured net benefit of a law is less than positive, it will be recommended for repeal by the legislature.

Creative Science of Laws: The creative science, or engineering discipline, of laws develops, accumulates, and reports knowledge of engineering design methodologies, and applies engineering best practices to the design of laws that solve, mitigate, or prevent societal problems [1, 2, 9]. It brings the knowledge, design expertise, quality programs, innovation, and ethos of science to bear upon the solution of societal problems by means of laws. The engineering design process of laws requires inputs from a wide range of fields such as sociology, law, software and systems engineering, statistics, and economics; it is the ultimate example of multi-disciplinary engineering. Through its ability to create just and efficacious laws, the creative science of laws will enable democratic governments to satisfy their public service obligations to the people.

The first step for the engineering discipline of laws is to establish quality design (QD) standards that require law design engineers to observe knowledge-based, problem-solving best practices for the creation of each new law, such as:

- Identify/analyze a societal problem that needs to be solved
- State the priority of the problem and the goal of the law
- Create a model of the law based on relevant data and ethical codes
- Test and refine the model for maximum efficacy

- Document and report all sources, methodologies, and observations

When the final design of the prototype law ("bill") has been tested and refined through the modeling and simulation process, and predicted to be a just and efficacious solution to a societal problem, it will be submitted to the legislature for a vote of acceptance (enactment) or rejection (veto). If the bill is enacted into law, it will be added to the government's enforceable body of laws and will then be subjected to periodic reviews of its performance by a science-based quality assurance (QA) program.

In addition to creating new laws, the engineering discipline of laws will conduct a quality improvement (QI) program to improve the structure and performance of existing laws after they have undergone their periodic QA evaluation. The standards of the QI program will be the same as the QD standards for the design of new laws. By this means, the laws of government will be constantly upgraded in their ability to satisfy the problem solving needs of government and the performance of laws will approach the characteristics of the "ideal law" [10]. The rule of engineering, that change is always characterized by improvement, will thus apply to the creative science of laws.

POLICY MAKING VS. LAWMAKING

The use of science for lawmaking will change the role of legislators. Legislative assemblies will consist of legislators who are chosen by the people to be representative trustees of the people. The purpose of the individuals thus elected (e.g., by popular and competitive elections based on universal suffrage and secret ballots) to the legislature will be to secure the rights and liberty of the people by discussing the great issues of the day and formulating, through debate and deliberation, priorities and goals for government action in the best interest of the people. That is, legislators will continue to "set policy" as is the current practice.

However, legislators will no longer design laws, for two reasons. First, the position of trustee will be a full time position, and trustees will not have the time to design laws. Second, the requirements for being a qualified designer of laws (e.g., PhD in law-design engineering) are far beyond the typical general-knowledge background of popularly elected legislators. Thus, legislators will "set policy" but will assign, by competitive bidding or other responsible method, the design of laws that carry out their policies, to qualified law-design engineers. Legislators, as trustees, will also have oversight authority of the government's development and application of quality standards for the design, evaluation, and improvement of laws.

THE SCIENTIFIC CONTROL SYSTEM OF LAWS

The creative and investigative sciences of laws will act synergistically with the government to create a science-based feedback control system for the government's body of laws. By its incorporation of quality standards (QD, QA, and QI) for the creation, evaluation, and optimization of laws, the lawmaking process will be self-correcting in the direction of

optimum outcomes in terms of the rights and liberty of the people (see Figure 1).
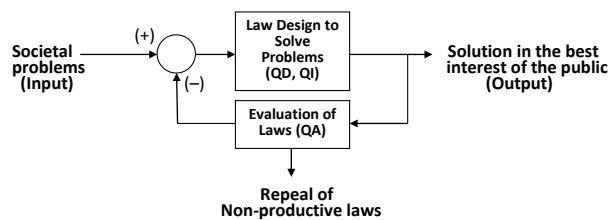
Figure 1. Scientific Lawmaking
Science-derived quality programs for laws (QD, QA, and QI) will transform the lawmaking process into a problem-solving feedback control system that is self-correcting in the direction of optimum outcomes.

With each cycle of the scientific lawmaking process, the sophistication of design and evaluation methods will improve, knowledge of the mechanics of laws will increase, the size and complexity of the bodies of laws (and of the government) will be kept to a minimum, and the performance of laws will improve in terms of effective and just problem solution, cost-efficiency, and safety.

SUMMARY OF SCIENCE OF LAWS PRINCIPLES

- The purpose of democratic governments is to secure the rights and liberty of the citizenry, of the people as a whole.
- The parameters that define "rights and liberty" are human rights, living standards, and quality of life standards.
- Laws are the means by which the ends of government are attained.
- Democratic governments satisfy their purpose by creating a body of laws ("rule of law") that solves (solves, mitigates, or prevents) the societal problems that degrade or threaten to degrade the rights and liberty of the people.
- Traditional lawmaking, currently used by all governments, is not a problem solving process; it is not capable of satisfying the purpose of democracy.
- The science of laws consists of a society of peers.
- The science of laws has two co-equal branches: Investigative Science of Laws and Creative Science of Laws.
- The objective of the investigative science of laws is to derive and accumulate knowledge of the mechanics of laws and of methodologies for the measurement and analysis of the outcomes of laws.
- The objective of the creative science of laws is to create laws that satisfy the purpose of democracy and that approximate the Ideal Law, and to develop law-design methodologies.
- The science of laws publishes a journal of peer-reviewed scientific reports of the investigative and creative science of laws.
- The science of laws publishes a reference data base of the scientific literature of the mechanics of laws and of scientific and best-practice methodologies related to the investigative and creative sciences of laws.

- The societal problems that are addressed by laws are the basis for the classification system of scientific reports of the mechanics of laws.
- Scientific reports of laws are made available to the public.
- The science of laws abides by a code of ethics.
- The science of laws observes quality design (QD), quality assurance (QA), and quality improvement (QI) programs for laws.
- Future law design engineers will be required to be qualified and licensed in accordance with a yet to be developed professional society and/or governmental body.
- Law design engineers will be required declare any actual and potential conflicts of interest.

CONCLUSION

The science of laws will apply scientific methodologies and ethos to the laws of government and the lawmaking process. The expectation for the science of laws is that it will experience the same patterns of success that now characterize every other field of science.

NOTES

1. The rights and liberty of the people are defined by the parameters of human rights, living standards, and quality of life standards (see reference 1, Appendix A).
2. The value of the scientific process, or "scientific method" is that it is a "truth machine:" To the extent that truth in the physical universe can be understood, the scientific process always and reliably seeks truth, accepts truth, and rejects non-truth.
3. Repealed laws will be recorded and stored in an archive of laws for additional studies and historical interest.
4. To meet the future need for law design engineers, new college curricula to the PhD level will need to be developed; the engineering design of laws is not currently taught in any school.
5. The "division of powers" between legislative, judicial, and executive branches of government will result in the assignment of the task of applying quality standards to laws and lawmaking to the executive branch of government. The legislative branch will have oversight of the performance of the executive branch in the performance of its quality control operations for laws.

REFERENCES

1. Schrunk, D., *THE END OF CHAOS: Quality Laws and the Ascendancy of Democracy*. QL Press, Poway, CA, 2005.
2. Science of Laws Institute web site: www.scienceoflaws.org.
3. Jefferson, T., "*Declaration of Independence*." Great Books of the Western World, vol. 43, Encyclopaedia Britannica, Inc. Chicago, Illinois. 1952.
4. Pound, Roscoe, *An Introduction to the Philosophy of Law*. Yale University Press. New Haven, Connecticut. 1922.
5. Beutel, Frederick K., *Experimental Jurisprudence and the Scienstate*. Fred B. Rothman & Co. New Jersey, 1975.
6. Stith, Richard, "*Will There Be a Science of Law in the Twenty-First Century?*" 22 Revue Generale de Droit, pages

373-379. Tenth Conference on the General Science of Law, held November 4, 1988, in Valparaiso, Chile.

7. Merton, Robert, "*Lecture 11: The Ethos of Science*," http://nptel.ac.in/courses/109103024/pdf/module2/SM%20Lec%2011.pdf

8. Crosby, P., *Quality is Free*. McGraw-Hill. New York. 1979.

9. Schrunk, David, "*The Systems Engineering Approach to the Design of Laws*." Proceedings of the Conference on Systems Engineering Research (CSER), St. Louis, MO, 2012.

10. Schrunk, D., "*The Ideal Law of Government*." Proceedings of the Eighth International Space 2002, pp. 580-586, American Society of Civil Engineers, Reston, VA, 2002.

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Better Lawmaking: Applying Systems Engineering-Based Requirements Analysis and Management

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ABSTRACT

Law is at the cornerstone of any peaceful and orderly society where the principles of justice and liberty for all are valued and shall prevail. As society evolves, there is a constant need for the making of new laws in order to harmonize existing and emergent social sub-systems to include people, the environment, business, and technology. However, there is currently no real science involved in the making of new laws. The precedents-based doctrine of stare decisis constituting the case by case foundation of the common law system has reached an inefficiency level which has led to the making of too many laws with no pre- or post-implementation rationale in regards to their true impact on quality of life. The present paper discusses the potential merits of using the principles of systems engineering to improve the quality of new lawmaking.

INTRODUCTION

The Constitution of the United States of America as promulgated by its founders constitutes the root of law making in the US, and thus establishes fundamental requirements with which any legislation must aligned in order to be in full force and effect. Whenever a law is declared to be anti-constitutional by the US Supreme Court, such law is deemed to be expelled or modified. Although the US Constitution provides the basic principles for a just society, more provisions are necessary to account for the complexity of our social systems. Very soon after the adoption of the Constitution, amendments to it were proposed and ratified, to include the Bill of Rights (or the first 10 amendments). Since then, thousands of legislations have been adopted.

Among the numerous laws that have been approved by Congress, how many are truly essential? Following their implementation, how many laws are monitored for the effectiveness on the social issues they are supposed to address? How were these laws developed and stated in the first place? What were the criteria for quality assurance in the formulation of these laws? Among all of the members of Congress who voted to approve or reject bills, who was really competent to assess the merits or drawbacks of these new laws? The sad reality is that there is currently no science of law used in the creation of new legislations. Anyone can propose a bill and as long as a majority of the members, based on their gut feeling, believe that the bill should become a law, then such law is

ratified without further analysis on how it will affect the social system or sub-system(s) to which it was intended.

There must be an improvement in the way laws are created, stated, adopted and monitored. The current paper does not intend to put in question our entire law system, but instead proposes the establishment of a science of lawmaking which shall govern the creation and approval processes involving new laws as well as monitoring and controlling of existing laws with the taking of actions necessary to enforce, improve or retract laws as deemed necessary in the best interest of justice, democracy and quality of life. The concept of scientific lawmaking has already been publicized by the "The Science of Laws Institute" and its founder David G. Schrunk [1]. We will focus here on the potential applications of requirements analysis and management, well established in systems engineering, to the science of lawmaking.

WHY SYSTEMS ENGINEERING?

A system can be defined as an ensemble of elements interfacing and acting together coherently, either directly or indirectly, and in harmony to accomplish a function or set of functions with pre-determined performance metrics in a defined environment. Examples of systems are: a car, an airplane, a satellite, a cellular phone, a computer, a society.

Systems engineering consists of the art and science of translating customers' needs into sets of solution-free requirements and through a process of decomposition, allocation and derivation of such requirements, developing the best possible design and architecture of the system that shall be optimized to meet the initial operational and performance requirements while respecting allocated budget and developmental schedule. In doing so, engineers have learned

that the system has to be construed as a whole, and each aspect of the system shall be integrated from initial concepts to development and through the entire life cycle of the system. Design modifications are exponentially costly at later phases in the development cycle. The several aspects of engineering for the system in development are represented in figure 1 below.
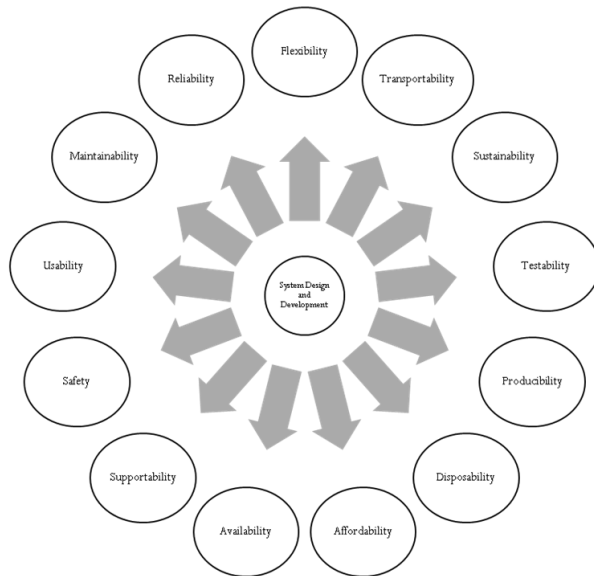
Figure 1. System Design Considerations

In order to avoid discrepancy among the development team, requirements statements must be clear and free of ambiguities. The following attributes to requirements statements are well established in the system engineering community. Requirements statements shall be:

- Necessary
- Implementation independent
- Unambiguous
- Complete
- Singular
- Feasible
- Verifiable
- Correct
- Conforming

Furthermore, in order to avoid any biases in regard to the final solution during development, requirements shall refer to What needs to be done, not How to do it. This enables specialty engineers involved with the project to have some leverage in regard to the possible configurations under investigations and allow them to choose the best possible design solutions as the system progresses.

During the concept and developmental phase of the project, requirements must be validated as suitable for the system in development. Validated requirements are then deemed to be implemented, and traced. Traceability of requirements is very important as in the test and evaluation phase of the system, each component, along with the system as a whole are tested in order to verify that all requirements have been implemented and implemented correctly. Once all operational and performance tests are completed, the system is deemed to be validated (or

verified). For references in regard to systems engineering methodology and requirements analysis and management, the reader can refer to the following references: INCOSE [2], Blanchard [3], and Grady [4].

HOW TO APPLY TO SOCIAL SYSTEMS?

Social systems obviously differ from other type of systems such as satellite, aircraft or telecommunication devices. However, the rigorous requirements methodology used in systems engineering starting with the elicitation and validation of requirements up to their post implementation verification, can be applied for scientifically sound lawmaking.

One of the major challenges in the process of system engineering-inspired lawmaking will be not to confuse requirement and law as both are statements, the first one being a characteristic that must be satisfied by the second which is ultimately the end product. David Schrunk [1], describes 5 fundamental requirements that must be met when writing laws. The ideal law of government shall:

- Be simply stated and have clear meaning.
- Be completely successful in achieving its objective(s).
- Interacts synergistically with other laws.
- Produce no detrimental side effect.
- Optimally serves the purpose of democracy.

To these five, I would add:

- Must align with the United States Constitution as amended.
- Promote liberty and justice for all.

One of the most important steps in requirement analysis consists of requirement elicitation. Once the major operational and performance requirements of a law have been identified, the process of further decomposing, deriving, and allocating the necessary requirements which will ultimately drive the design and development of the optimum law can be inspired by the following sources:

- The United States Constitution as amended
- Precedents from the doctrine of stare decisis (although precaution should be taken to avoid irrelevant re-use)
- Common sense
- New circumstances
- Activist group demands
- Unexpected events
- Environmental threats
- Importance of education
- Extreme circumstances
- Others…

Figure 2 depicts the life cycle of a law, from its conception/design to its approval, followed by its enforcement, and retraction or amendment if and whenever needed. The process starts by identifying clear needs to be satisfied with the new law. Careful requirements analysis shall then identify a series of derived and allocated requirements that must be met in order to build the correct law. Each proposed requirement should be analyzed and either validated or rejected. Validated requirements shall then be deemed to be implemented. The lawmaking efforts shall implement the optimum solution consisting of a law which will meet all of its social objectives. Once the law is written, a verification process shall take place

to assure that all requirements have been implemented. Finally, once in operation, the law shall be monitored for performance and eventually re-affirmed, or amended or retracted depending on its ability to meet objectives without significant secondary effect.

Post-implementation traceability can be useful in order to evaluate the merits and drawbacks of a new or existing law. Such traceability can help answering questions like:

- Does the law, as written, satisfy the statement of needs and initial fundamental requirements?
- Is the law, once approved, properly enforced?
- Is the law observed?
- Does the law in operation meet its original objectives?
- Are there any negative side effects related to the enforcement of the law?
- Should the law be kept as is, modified, or retracted?
- What are the long term benefits of the law (evaluated as measure of effectiveness)?

Needs Objectives	• The incentives to create a law • Clear statement of needs
Requirements Validation	• What is needed from the Law
Design	• How to achieve requirements • Lawmaking
Verification	• Requirements verification and • Law Approval
Operations	• Law Enforcement
Retirement	• Retraction or amendment of the law (if and when needed)

Figure 2. A Law Life-Cycle

Similar to Figure 1 listing several considerations in the process of defining requirements for engineered systems, Figure 3 depicts some considerations that could be useful in the process of new lawmaking. There is obviously much more than the precedence cases of the stare decisis as criteria to be considered in lawmaking and it is time to institutionalize lawmaking. We are not suggesting here that electronic and mechanical engineers take over the law making in the US. But lessons from systems engineering can largely benefit the law community and I believe that scientific lawmaking should become a part of any law program. Scientific lawmaking once recognized by major law schools as an essential discipline, will most likely gain popularity at an unsurpassed pace.

Better lawmaking may prevent bills such as Bill H.R. 185 "The Regulatory Accountability Act" from even be considered for implementation. If approved, such legislation would require federal agencies formulating new regulations to adopt "the least costly rule considered during the rule making" in almost all cases. This type of aberration obviously focuses on only one of several considerations to be accounted for in the process of requirements validation for a new law. It is very unlikely that it would pass the first design step of scientific lawmaking but, under current circumstances, could possibly interest a majority of Congress members who are overwhelmed by their busy schedules yet anxious to make decisions.
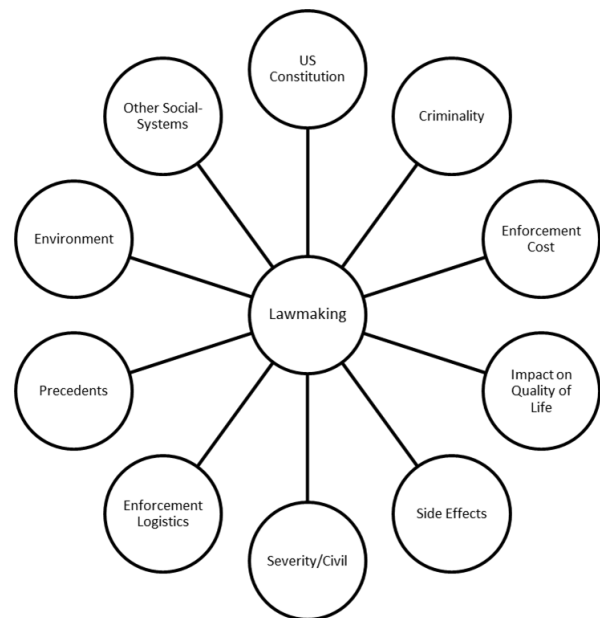
Figure 3. Lawmaking Design Considerations

There is a tremendous pending opportunity for the ones who will pioneer scientific law making and who will participate in the reshaping US laws. Not only can we foresee better new laws, but also the application of a scientific approach to the revision of all existing laws could lead to the reduction of the numbers of laws, the improvement of re-affirmed laws, and as a result, a better legal system. Such a large endeavor can only be achieved by recognizing the need for lawmaking engineering and institutionalizing it so that a career in the field can become a reality for some of our future law graduates.

REFERENCES

1. *The End of Chaos; Quality Laws and the Ascendancy of Democracy*, David G. Schrunk, Quality of Laws Press, 2005.
2. *System Engineering Handbook*, INCOSE, 2015, John Wiley & Sons, Inc.
3. *Systems Engineering Management*, Benjamin S. Blanchard, 4th Edition, 2008, Wiley.
4. *Systems Requirements Management*, Jeffrey O. Grady, 2nd Edition, 2014, Elsevier.

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He recently was appointed to the position of Vice-President of Portfolio and Project Management at BlueNovo Biosystems Inc. an early stage biotechnology company focusing on revolutionary genome sequencing technologies as well as rapid profiling diagnostics of infectious diseases.

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Integrative Propositional Analysis: PROCEEDING The Missing Link for Creating More Effective Laws

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ABSTRACT

Historically, there has not been a way to objectively evaluate laws "on paper" before they are enacted to determine if they would work as expected. Instead, the history of creating and enacting laws has been based on a patchwork approach – marked by conflict between advocacy groups and the creation of a large number of laws each having little value. This problem is common across the social/behavioral sciences. Like laws, the development of models, theories, and policies has not met with great success.

The present paper briefly presents a stream of research for evaluating conceptual systems (including theories, policies, models, and laws) culminating with Integrative Propositional Analysis (IPA). IPA has been used to objectively evaluate theories, policies, and proposed laws to predict their potential for successful application. Here, IPA is used to evaluate a bill before Congress as an example for how IPA may be used to objectively evaluate and improve laws before they are implemented. This systems-based approach is a new tool for creating and evaluating laws to identify the potential for unanticipated consequences. Additional directions for research are suggested along with the suggestion that IPA be adopted as an ISO quality standard for the evaluation of laws.

Keywords: Science of Laws, Integrative Propositional Analysis, Metapolicy

INTRODUCTION

Political science, in the US, formed early in the 20th century with a focus on data collection and the testing of hypotheses from theories based in the natural and social sciences (Smith, 2015). While journals of political science provide a venue for publication of research, contrasting perspectives, and intellectual disputes, they have never settled "once and for all, any major analytical, conceptual, empirical, or normative dispute" (Isaac, 2015, p. 279). Not only has the science failed to settle important debates, but today's scholars are increasingly shying away from solid policy recommendations; essentially reducing the relevance of the field (Desch, 2015).

Under that cloud of reduced relevance, it should come as no surprise that policies frequently fail (Wallis, 2011) and our ability to create effective laws is increasingly called into question (Wood, 2015). Traditional approaches to lawmaking are seen as failing for multiple reasons. These include: the creation of laws in lieu of solving the underlying problem, poor definition of the underlying problem, lack of prioritization for social problems, failure

to set measurable goals for the outcomes of implementing laws, lack of expertise among law makers, failure to construct computer models to test laws, failure to account for costs of laws, failure to account for risks and side-effects of laws, acceptance of vagueness and design defects, acceptance of political agendas such as pork-barreling, laws are founded on opinion and ideology rather than solid knowledge, lack of supporting citations, and lack of outcome evaluation (Schrunk, 2005; Shrunk, 2015).

In the present paper, from the above list, we focus on an approach for understanding how well the situation is understood. Additionally, for understanding the potential for unanticipated outcomes of a proposed law by proposing how to predict a law's potential for successful implementation. The difficulty for predicting such efficacy is common to the social/behavioral sciences, for which a potential solution has only recently emerged.

Integrative Propositional Analysis (IPA) was developed to evaluate the structure of theories of all sciences. It has also proven a useful tool for evaluating policies and laws. This kind of evaluation is focused on an analysis of the internal logic-structures of the bill as useful indicators for the bill's sense-making ability and as predictors for its potential success or failure. There are two other important assumptions. First, that the claims of the bill are based on good empirical data. Second, that the bill will be implemented as proposed. Those two may

present additional challenges to the effectiveness of this bill. However, they are not part of our present analysis.

In the present paper, we first present IPA, including a stream of research where IPA has been used to some benefit. Next, we apply IPA to analyze a Congressional bill to predict the potential usefulness of that bill, were it to become law. Finally, we tabulate our analyses in a rating system, providing multiple measures to clearly and effectively indicate "how much science" and "how much sense" the bill represents. This rating system will allow diverse readers to easily compare various bills and policy proposals.

This is an important topic and focus because IPA is the only objective tool for evaluating theory in the field of psychology (Wallis, 2015), and perhaps beyond. Additionally, IPA is currently being used to suggest the value of research proposals based on the structure of theory and policy within the proposals (e.g. Cotae, 2015). Finally, IPA is a useful approach because it relates directly to the reasoning ability of the electorate – which is distinctly different from their level of education (Kahan, Peters, Dawson, & Slovic, 2013). That difference is key to understanding the present approach. Data and logic are differentiable, but they are not separable. Together, they are more useful than either one alone.

INTEGRATIVE PROPOSITIONAL ANALYSIS

Integrative Propositional Analysis (IPA) is an emerging method used to evaluate and integrate conceptual systems such as theories, mental models, and policy models (Wallis, 2010b). What we will refer to as "models." In this paper, we provide an overview of IPA, its legitimacy as a scientific approach, and a brief example of its usefulness for providing objective, non-partisan, analyses of a proposed law and generating critical questions to support discourse in the public sphere.

Within the study of sociology, scholars have long held that conceptual systems, such as models, generally have some kind of structure (Dubin, 1978). Looking at the study of cognitive systems, an interesting stream of research dates back to the mid-twentieth century. In the 1950s researchers suggested that concepts in our minds exist in some kind of interrelated structures (Cronbach, 1955) as conceptual systems.

Those conceptual systems (including those of individuals and organizations) are reflected in texts such as correspondence, speeches, declarations, and policies. Studies have applied Integrative Complexity (IC) to analyze those forms of text. IC quantifies the relationship between concepts of the text on a scale of one to seven. More simple statements have a lower score, and more complex texts have a higher score. Studies have involved students (Curseu, Schalk, & Schruijer, 2010), managers (Wong, Ormiston, & Tetlock, 2011), world leaders (Suedfeld & Rank, 1976), and others.

The Integrative Complexity research stream shows how conceptual systems that are more complex reflect increased ability to learn, to lead, and to make effective decisions. In short, more systemic understanding allows for greater success. Here, we use IPA to determine the level of systemic understanding.

IPA involves six steps:
1. Identify the propositions within one or more conceptual systems (statements about things and their relationships).
2. Diagram the causal relationships between the concepts within the propositions (one box for each concept).
3. Combine those smaller diagrams where they overlap to create a larger, integrated, diagram.
4. Identify and count the Concatenated concepts (those concepts resulting from two or more causal concepts).
5. Identify and count the total number of concepts to determine the Complexity of the integrated model.
6. Calculate the Systemicity (also known as Robustness or Interrelatedness) of the integrated model by dividing the number of Concatenated concepts by the total number of concepts.

For a very brief and abstract example, consider Figure #1. That figure has three variables/concepts (A, B, C), therefore, the Complexity is C = 3. There is one concatenated concept (C). Therefore, the Systemicity is S = 0.33 (the result of one concatenated concept divided by three total concepts).
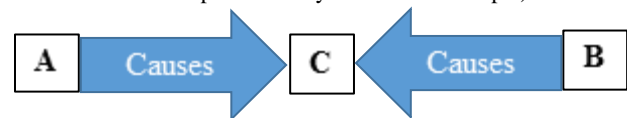

Figure 1. Abstract example of a model for demonstrating IPA.

Recent research showing the relationship between the "Systemicity" (degree of interconnectedness between the concepts) of models and their usefulness in practical application. IPA provides a useful (though heterodox) approach to evaluating models. Instead of working on the traditional assumption that more data provides better models, IPA works on the assumption that more Systemic interrelationships between the data provides better models. The two perspectives are not mutually exclusive. Indeed, while orthogonal, they are complimentary. Based on this new transdisciplinary approach, IPA has proven useful for generating insights in a variety of fields including policy (Wallis, 2011), psychology (Wallis, 2015), systems thinking (Wallis, 2014), and others.

Rather than asking "what should we do" in a situation, we are creating a more complex map to allow more complex reasoning such as, "what will be the costs and consequences." To put it another way, to justify a proposed law, that proposal should contain an explanation of how the world works and how the law will change the way it works. From another perspective, we might think of a bill with low Systemicity score as presenting a kind of system "pathology" as occurs when natural system's functions are interrupted (Yolles & Fink, 2013). This systems pathology perspective is similar to understanding pathologies in biological and social systems. Whether the system is conceptual, social, or biological, if the parts are not connected, the system will not operate at its full potential. Thus, IPA is very useful for identifying important questions.

By addressing structure, IPA provides a useful alternative to relying on purely empirical data in efforts to make policies more scientific or "evidence-based." This is important because evaluating policy claims based only on "data" or "evidence"

creates difficulties. That practice has led to divisive partisan arguments. Part of the problem is that what counts as evidence is often not well explained or understood (Berk, 2011). Consider, for an abstract example from academia, research streams where one scholar suggests that A causes B; yet, another scholar's research suggests that B is causal to A. This "flipping" causes confusion and conflict among researchers (Kelly & Mayo-Wilson, 2012).

It is this kind of issue that also causes confusion among members of Congress and the voting public. For a more practical example, before the (tumultuous) progress towards a generally accepted view of global warming, there were previously scientific claims advanced on global cooling (Ponte, 1976). In the face of such confusion, the electorate stands in need of a new tool.

One key to resolving this confusion is to avoid linear causal relationships (e.g., A causes B) and instead identify two or more causal elements for every one resulting element. An example is studying how changes in A with changes in B combine to cause changes to C (Kelly, 2007). In IPA terminology, those three-part relationships are understood as a concatenated structure. Within that kind of structure, C is the concatenated concept and is held to be well-explained or well understood compared to other non-concatenated concepts.

Here, according to the standard use of IPA, we have used the text of the bill https://www.congress.gov/bill/113th-congress/house-bill/4286 to diagram concepts and their causal connections. Each separable concept is inside a box while causal connections are indicated by arrows (see Appendix A).

At the start of each Title of this bill there is a set of "findings" (along with a few relevant mentions of the "sense of Congress" that reflect an underlying understanding). While these may (or may not) represent a preponderance of scientific evidence, IPA provides a "shortcut" – a way to investigate the underlying logics of those claimed findings to see if they actually make sense. That is to say, the bill "says" that they are findings. However, we are not so certain that they make "sense" as a coherent conceptual system.

Here, we included all sections identified as "Findings" and "sense of Congress." It may be assumed that the sum of these understandings represents the belief system of Congress relating to this Bill. And, if that understanding has a measurably high level of coherence, it would suggest that the underlying dynamics of the situation are well understood – and we might infer that this Bill is a wise one. However, that is not the case.

While the bill has a fairly large number of concepts (Complexity is C=27) those concepts have a very low level of connection. The Systemicity of this bill is a mere 0.07 on a scale of zero to one (with one being the highest).

Models with a higher level of Systemicity are more likely to reach their expected results (stated effects) (Wallis, 2010a). A model with a Systemicity of 1.0, therefore, might be expected to reach its goals about 100% of the time. By extrapolation, therefore, we might expect that this bill has only about a seven percent chance of attaining its stated goals. Or, to put it another way, the bill has about a 93% chance of provoking unanticipated consequences (unstated effects).

An important overarching concern about the structure of this bill is that there many atomistic claims and assumptions (Concepts 11-27). Those are of very limited validity because they do not show cause and effect relationships required of effective models/theories/polices. From the perspective of the electorate, this means each concept is surrounded by a cloud of assumptions – no definitive understanding can be reliably inferred –arguments are highly likely to ensue. To improve the structure of the model, causal relationships should be identified between the concepts – where supported by rigorous empirical studies.

KEY QUESTIONS FOR IMPROVEMENT

Generally, for each concept, we should ask (and the bill's sponsors should respond), "What is causal to that concept?" This is particularly important for 1-4 and 7-27. Similarly, we should ask what is resultant from each concept (1-27). Of course, it would also benefit the model to ask what causal connections exist between each of the concepts.

Additionally, we must consider each of the eight casual connections existing in the diagram. Critically, we must ask if those claims of causal relationships are valid based on preponderance of scientific evidence. For example, where the diagram shows how "2>causes>5." Does more export really open new energy resources? Or, does the opening of energy resources open new opportunity for exports? Each statement should be clearly supported by rigorous scientific studies.

An important consideration of success for any model is the percentage of concatenated concepts. Here, only two concepts are concatenated (#5 & #6) and so have some validity. To improve the model, it is necessary to identify causal relationships. For example, #9 (environmental responsibility). What two (or more) concepts support this? How is it measured? What reduces environmental responsibility? Similarly, #10, what also increases the security and efficiency of the energy market? What results from a more secure market? Importantly, #1 (technological advances) seem responsible for improving the development of the energy market. However, it is not clear what drives those technological advancements. It may be that by focusing on advancing our technology, we may reach a point where we no longer require oil and gas – thus rendering the entire argument moot.

The old adage is very useful, "If you can measure it, you can manage it." However, many concepts here may be difficult to measure. For example, #10. The bill should be modified to explain how to measure the security and efficiency of the North America energy market. To improve the bill, the same question should be asked (and answered) for each of the concepts presented in the model.

Another critical question concerns those things which are not shown in this bill. For example, who bears the costs and who reaps the rewards (this should be asked about economic, environmental, and civic concerns).

Another relevant area for exploration is a search for alternatives. For example, this model indicates a number of things that lead to job growth and economic growth. However, those are not the only things which support growth. We should ask, "What else leads to job growth?" And, importantly, where should we invest our public and private efforts to support job and economic growth? And, of closely related significance, what are the limits of economic growth? Can it continue

indefinitely? If not, those limiting factors should be indicated on the model.

The underlying question to all of these is, "How do we increase the Complexity and Systemicity of the bill?" We do that one step at a time by asking questions that will test the conceptual connections and generate new ones.

The diagram of the bill may be understood as a road map. Without advancing the Systemicity of the map, it is a problematic map containing many cities free of connecting roads. As such, it is not useful for reliable navigation.

It is reasonable to hypothesize on the potential for understanding, or at least estimating unintended consequences. While this is an area for extensive study, we suggest that the opportunity for unintended consequences may be the inverse of the intended consequences. And, because a low level of Systemicity provides a low chance of predictable results, we anticipate that such a law would provide a high level of unanticipated consequences.

Following our metaphor, a road-trip using this dysfunctional map will lead to many arguments among the participants. While this may be an amusing situation in a Hollywood movie, using such laws to navigate our nation is not.

CONCLUSION

In this paper, to demonstrate the usefulness of IPA, we have conducted a structural analysis of HR4286. In this study, we have avoided partisan arguments around whether the bill might be "good" or not. Our sole concern with IPA is to understand the extent to which the authors of the bill seem to understand the situation (as reflected in the text of the bill), how that understanding supports the reasoning ability of the electorate, and how it relates to the potential for the bill to achieve its stated goals, and (in contrast) the law's potential for creating unanticipated consequences.

IPA provides a new and effective way to evaluate laws. Its measures of Complexity and Systemicity allows us to evaluate laws with a previously unavailable level of rigor. Thus, we have a new and useful approach for evaluating and improving our laws that is clear, scientific, rigorous, non-partisan, and objective.

Studies into the structure of theory from a various fields suggest that they are only a fraction of their potential. The same appears to be true of our laws. We have been creating laws on a level of technology comparable to "stone knives" and believing that to be the best that is possible. Now, we see that we may make laws of a higher order.

While the present paper is focused on evaluating a proposed law as an example for evaluating all proposed laws, it is entirely possible to use IPA as a design tool in the process of law-creation. Such an approach would include the integration of empirical research to create a knowledge map. Such a map would indicate areas where additional research might be conducted to improve the map and lead to the creation of laws with higher IPA scores of Complexity and Systemicity. Essentially, any concept on the map which is not concatenated may become so by adding additional concepts and causal linkages (supported, of course, by empirical research).

To be successful, such a map would also be non-linear. This would help to avoid the problems association with the nonviable linear approach to law-creation (Hossain, 2015), support an evidence-based and systems engineering approach to law-creation (Sahlin, 2015; Troncale, 2015).

Metaphorically, a small project is like a small cannon. If it is poorly aimed, it will likely cause little damage. However, a large cannon that is poorly aimed is more likely to cause a great deal of damage. HR 4286 has a vast scope with significant implication for energy, economics, the environment, civil rights, and other areas. Given the large scope of the bill, it seems reasonable to suggest that the unanticipated consequences will be of much greater scope than the expected results. This, in turn, suggests that it is more important to achieve a higher level of Systemicity for bills of greater scope.

IPA may be the only tool for objectively evaluating the structure of laws – the logics. Therefore, because structure is orthogonal to and complimentary with empirical analysis, we may reasonably suggest that IPA be adopted as an ISO standard for evaluating laws prior to their implementation.

REFERENCES

Berk, R. (2011). Evidence-based evaluation research: Some lessons from 35 years of the Evaluation Review. *Evaluation Review*, 35(3), 191-203.

Cotae, C. E. (2015). Regional performances in the context of a transition towards the circular economy: Structuring the assessment framework. *Ecoforum*, 4(1), 140-146.

Cronbach, L. J., and Paul E. Meehl. (1955). Construct validity in psychological tests. *Psychological Bulletin*, 52(4), 281-.

Curseu, P., Schalk, R., & Schruijer, S. (2010). The use of cognitive mapping in eliciting and evaluating group cognitions. *Journal of Applied Social Psychology*, 40(5), 1258-1291.

Desch, M. (2015). Technique trumps relevance: The professionalization of political science and the marginalization of security studies. *Perspectives on Politics*, 13(2), 377-393.

Dubin, R. (1978). *Theory building* (Revised ed.). New York: The Free Press.

Hossain, N. (2015). A technocratic approach to effective decision making in policy design. *The Science of Laws Journal*, 1(1), 5-8.

Isaac, J. C. (2015). For a more public political science. *Perspectives on Politics*, 13(2), 269-283.

Kahan, D. M., Peters, E., Dawson, E. C., & Slovic, P. (2013). Motivated numeracy and enlightened self-governmrnt. *The Cultural Cognition Project*. Retrieved from http://static1.1.sqspcdn.com/static/f/386437/23982003/1385735927633/wp_draft_1.5_9_14_13.pdf

Kelly, K. T. (2007). Simplicity, truth, and the unending game of science. In S. Bold, B. Löwe, T. Räsch, & J. v. Benthem (Eds.), *Foundations of the Formal Sciences V: Infinite Games* (pp. 368). London: College Publications.

Kelly, K. T., & Mayo-Wilson, C. (2012). Causal conclusions that flip repeatedly and their justification. Retrieved from http://arxiv.org/ftp/arxiv/papers/1203/1203.3488.pdf

APPENDIX A: CAUSAL DIAGRAM OF HR 4286
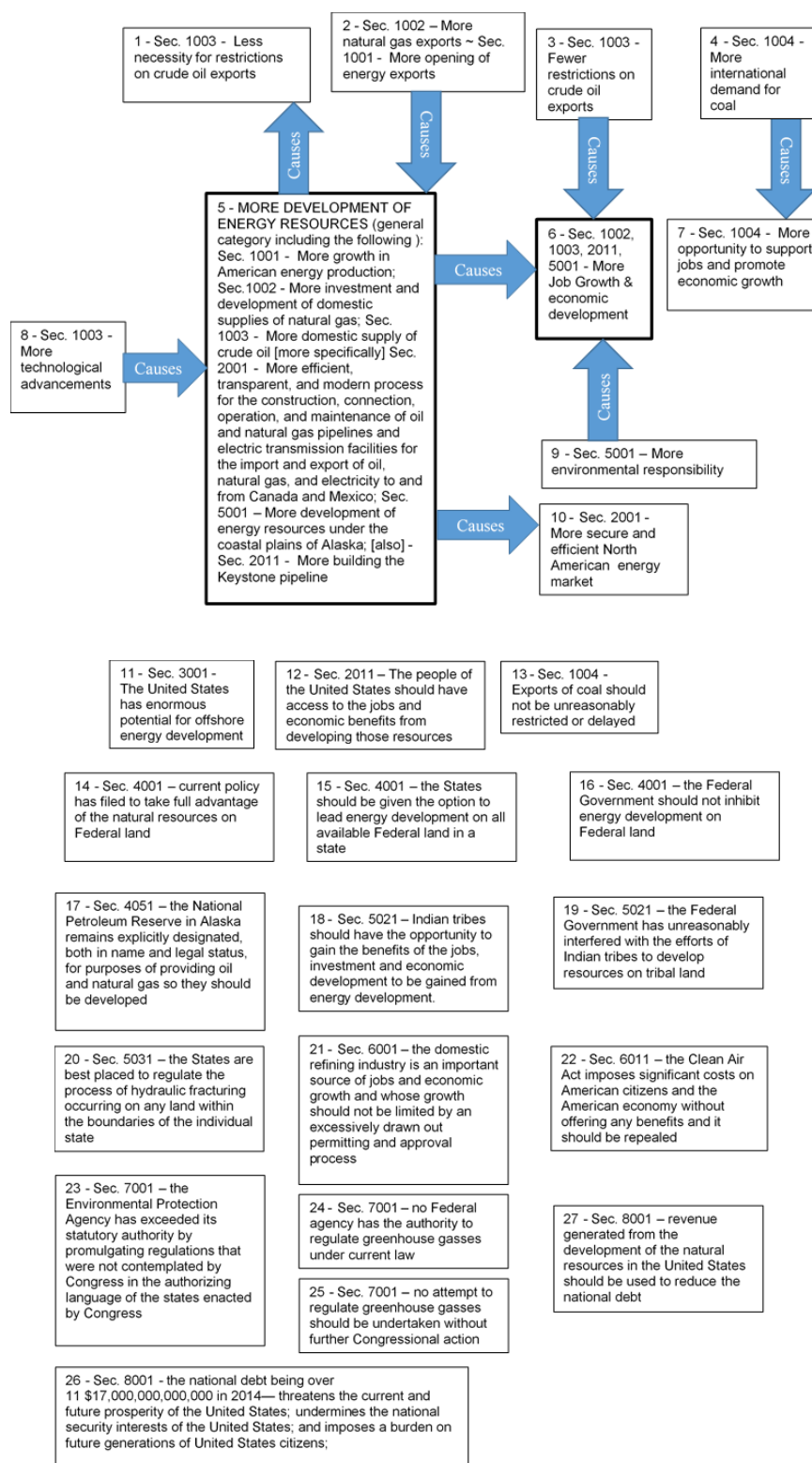
REFERENCES (CONTINUED)

Ponte, L. (1976). *The Cooling: Has the Next Ice Age Already Begun?* Uper Saddle River, NJ: Prentice Hall.

Sahlin, J. P. (2015). Requirements, specifications, and design: Improving efficacy of lawmaking though requirements management. *The Science of Laws Journal*, 1(1), 19-25.

Schrunk, D. G. (2005). *The End of Chaos: Quality Laws and the Ascendancy of Democracy*. San Diego: Quality of Laws Press.

Shrunk, D. (2015). The science of laws: Introduction and history. *The Science of Laws Journal*, 1(1).

Smith, R. M. (2015). Political science and the public sphere today. *Perspectives on Politics*, 13(2), 366-376.

Suedfeld, P., & Rank, A. D. (1976). Revolutionary leaders: Long-term success as a function of changes in conceptual complexity. *Journal of Personality and Social Psychology*, 34(2), 169-178.

Troncale, L. (2015). Two essential sources for aplication of systems engineering to a science of laws. *The Science of Laws Journal*, 1(1), 9-18.

Wallis, S. E. (2010a). The structure of theory and the structure of scientific revolutions: What constitutes an advance in theory? In S. E. Wallis (Ed.), *Cybernetics and systems theory in management: Views, tools, and advancements* (pp. 151-174). Hershey, PA: IGI Global.

Wallis, S. E. (2010b). Towards the development of more robust policy models. *Integral Review*, 6(1), 153-160.

Retrieved from http://www.integral-review.org/documents/Wallis,%20Toward%20More%20Robust%20Policy%20Models%20Vol.%206%20No.%201.pdf

Wallis, S. E. (2011). *Avoiding policy failure: A workable approach*. Litchfield Park, AZ: Emergent Publications.

Wallis, S. E. (2014). A systems approach to understanding theory: Finding the core, identifying opportunities for improvement, and integrating fragmented fields. *Systems Research and Behavioral Science*, 31(1), 23-31.

Wallis, S. E. (2015). Integrative Propositional Analysis: A New Quantitative Method for Evaluating Theories in Psychology. *Review of General Psychology*, 19(3), 365-380. Retrieved from http://dx.doi.org/10.1037/gpr0000048

Wong, E. M., Ormiston, M. E., & Tetlock, P. E. (2011). The Effects of Top Management Team Integrative Complexity and Decentralized Decision Making on Corporate Social Performance. *Academy of Management Journal*, 54(6), 1207-1228.

Wood, J. N. (2015). It is time to advance the science of laws. *The Science of Laws Journal*, 1(1), 1. Retrieved from http://www.scienceoflaws.org/common/getfile.aspx/477922

Yolles, M., & Fink, G. (2013). Modelling mindsets of an agency. *Journal of Organisational Transformation & Social Change*, 11(1), 69-88.

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Potential Benefits and Challenges of CMMI® in Lawmaking

James ter Veen*

ABSTRACT

Capability Maturity Model Integration (CMMI®) is a process improvement model developed, patented and trademarked by Carnegie Mellon University. The origins of CMMI® date back to the late 1980's when it was initially developed to provide guidance for developing or improving processes relating to software development. The effort has since expanded to serve as a general framework and appraisal tool for any processes aligned to meet business goals (whether or not software is involved). Organizations applying CMMI® have been shown to improve performance in categories including cost, schedule, productivity, quality, and customer satisfaction. This paper and presentation will examine the potential benefits and challenges associated with implementing CMMI® for lawmaking bodies.

INTRODUCTION

Laws requiring corporate governance such as Sarbanes-Oxley (Sarbanes-Oxley, 2002) strive to ensure maturity of corporate processes in order to improve confidence of investors that certain levels of trust will be met (Brand et al., 2011). But is there any such process for law making? Perhaps application of the CMMI® framework could help.

The framework grew out of the Capability Maturity Model® which was constructed primarily to organize best practices of software development. The CMM® categorized five different levels of performance that could be used to describe the state of processes being followed by a software development organization. The levels described in the CMM are named: Initial, Repeatable, Defined, Managed and Optimizing.

An organization considered to be at the Initial level operates by the seat of their pants with little regard for requirements, architecture, scalability, configuration management, reliability or future maintainability. Results obtained by an organization at the second level of the CMM® are Repeatable. Processes followed by a level three organization are Defined and documented. Changes at the fourth level are Managed and performance is measured and monitored. At the top end of the scale, an Optimizing institution is not only highly organized with respect to requirements, architecture, scalability, configuration management, reliability and future maintainability but also is continuously improving their processes feeding back lessons learned from each step of each project into their procedures (Caralli et al., 2012).

CMM PLUS INTEGRATION EQUALS CMMI®

Many different capability models have been developed for

different disciplines other than software development. The CMMI® project combined three models into an improvement framework. The resulting merger of processes and practices is scalable and extensible enough to be applied to other organizations besides software development businesses. The framework doesn't give companies and organizations the answers needed to solve all of their problems and improve their product quality; instead it offers a guide for how to migrate existing standards, processes and procedures into a brighter future of continuous improvement which results in optimizations, higher quality, lower costs and increased profits.

The CMMI® Framework offers a basic structure that organizes common elements of models, rules and methods for generating models of an organization's way of doing business. The framework supports integration with existing disciplines and enables new disciplines to be added to CMMI® An organizing principle that helps reduce the complexity of modeling a discipline is the body of knowledge approach. There are four bodies of knowledge available for selecting a CMMI® model when evaluating a new discipline: Systems Engineering, Software Engineering, Integrated Product and Process Development, and Supplier sourcing (CMMI, 2002).

An organization can compare existing standards, processes and procedures it has in place to descriptions of the stages in the model to determine how mature their procedures are and what aspects of their procedures need improvement. Of course, one can always hire outside consultants to do the analysis. In this paper, we will do a simple analysis of the law making process in terms of the CMMI® framework.

We will use two of the CMMI® bodies of knowledge to guide our analysis of standards, processes and procedures involved in law making. The Systems Engineering body of knowledge focuses on customer needs, expectations & constraints which are all important aspects of law making. The Integrated Product and Process Development Body of knowledge focuses on ensuring a systematic approach and inclusion of collaboration of relevant stakeholders which are fundamental aspects of democratic governments.

After we examine the maturity of the law making process with respect to the CMMI® framework, level by level, we will look at potential benefits and challenges to the application of the CMMI® to the processes of making laws.

HOW DOES LAW MAKING STACK UP AGAINST THE CMMI® LEVELS?

Level 1 of the CMMI® framework, known as 'Initial', is characterized by performance of a process area and achievement of specific goals. If we look at the process of law making through history, we find the first recorded example of laws, the Hammurabi code which demonstrates performance of law making and achievement of very specific goals. The pattern of the 282 laws inscribed in clay tablets by the Sumerians is the straightforward 'an eye for an eye' pattern. These laws cover a wide variety of topics dealt with in modern law including contracts, liability, family law, and military service. They must have met the customer needs, expectations and constraints of Sumerian daily life in the kingdom while achieving the specific goal of a stable society. Collaboration of stakeholders, other than the King, may not have been a factor in Hammurabi's law making process but if so, that aspect is lost to history.

By and large, the process of law making by governments in western civilization followed the pattern of 'the King makes the rules' with two notable exceptions: The 186-year period of democracy in Athens and the legislative law making of the Roman Republic. Democracy in Athens did not involve a legislature or any elected representatives, all of the citizens voted on all issues large and small (Blackwell, 2003) making for extensive collaboration of all stakeholders. The Roman aristocracy laid down the laws in their time with some issues voted on by plebeians and called public law. Many of these were documented in the Justinian Code (Williamson, 2005). While these efforts included more participants in the law making processes and procedures they were still focused on achieving specific goals and can be described as meeting the Initial level of the CMMI® framework.

Through the dark ages that followed the collapse of the Roman Empire, the law making process in Western Europe was dictatorial at best until 1215 when rebel barons forced King John of England to sign the Magna Carta drafted by the Archbishop of Canterbury. The articles of the Magna Carta primarily functioned to protect the barons from the King but also included the foundation of habeas corpus and led to the establishment of the early English Parliament (Danziger &, Gillingham, 2004). Although typically assembled in those early days for the express purpose of raising taxes, the model of Parliament evolved and influenced the formation of the U.S. government and formal management of the law making process in many modern societies. This brings us to the second, or 'Managed', level of the CMMI® framework.

In addition to the capabilities of Level 1, a Level 2 organization plans the execution of processes by adhering to accepted policies. Skilled practitioners have adequate resources to perform the tasks and control the work products produced. Training is part of the standard process and work is performed in a planned, organized manner which can be monitored and reviewed. Stakeholders are involved in the processes and plans; deviations from the plans can be addressed with corrective actions (CMMI, 2002).

AN EXAMPLE ANALYSIS

Let's take a look at an example of modern law making in action in the US Congress and evaluate the process steps followed with respect to the CMMI® framework levels. The "No Social Security for Nazis Act" introduced to the House Ways and Means Committee by Representative Sam Johnson of Texas in November of 2014 is our example legislation which was passed relatively quickly with few complications and is therefore useful for our examination of the law making process.

A summary of the history of this Act describes the ideal, success-oriented flow for a congressional bill; introduced in the House, it passed the House, it passed the Senate, it was sent to the President, signed and became law in December of 2014. However, there was much more detail than meets the eye. Twelve process steps were executed in the House, followed by three actions in the Senate, then it was sent back to the House, then to the President where it lingered for eight days before being signed and finally made into law. The act itself is fairly simple: it amends title II (Old Age, Survivors and Disability Insurance) (OASDI) of the Social Security Act to consider Nazis to be removed under the Immigration and Nationality Act and so to have their OASDI benefits terminated (Library of Congress, 2015).

So how does this stack up against the CMMI® model? The flow of the House process is summarized in Figure 1.
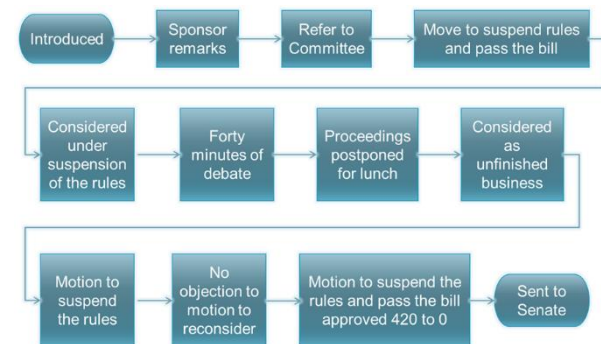
Figure 1. House Process Flow - No Social Security Act for Nazis

Performance is managed; there are some odd rules but apparently there are rules that allow a motion to suspend the rules and move to a vote. There is still a debate even if the rules are suspended, so policies do indicate that processes will be followed under any circumstance. Plans are in place for performance and that is evidenced by the lunch break to allow for sustenance needed to conduct congressional business. Performance resumes after lunch with more processes to bend the rules. The act passes a vote unanimously and the vote is recorded in Roll count #537 (Library of Congress, 2015) showing that the work products are controlled. Resources are assigned (and in this case – unassigned from the Nazis). Is there organized Training on how to perform these processes? Certainly there are law schools but being a lawyer is not

necessarily a requirement for being a congress person. There is on-the-job training for interns so we could check off training. The organizational activity of the government can be monitored as it is recorded live on CSPAN, in the congressional record and on the web. How well planned are the activities of Congress may be a subject for debate beyond the scope of this paper, so in measuring against CMMI® Level 2, a majority of the 'Managed' characteristics have been met in our simple example.

How do the Congressional procedures of law making rank against the CMMI® Level 3? The third level is labeled 'Defined' and at this level an organization's standard processes cover multiple activities and can be tailored to meet specific needs. These standard processes are improved over time by a Level 3 organization. Defined processes are consistent across the organization. Level 3 processes, standards and procedures are described in more detail and performed more rigorously than the actions of a group at the Level 2 'Managed' process. Process improvement information at Level 3 is easier to understand, analyze and use (CMMI, 2002).

Standard Congressional processes were tailored to allow suspension of the rules to vote on the "No Social Security for Nazis Act"; an issue to which no one really objected, so we can check off the first criteria of Level 3, standard processes can be tailored.

Can we say congressional processes have improved over time in accordance with the next Level 3 criterion? Certainly they have changed since the time of the first Congress in 1789 when the Constitution was established, the amendments known as 'the Bill of Rights' were passed, and many government procedures were first enacted (House of Representatives, 2015). Whether subsequent changes over time have resulted in "improvements" in Congressional processes, standards and procedures could be the subject of another entire study.

The next Level 3 criterion is that an organization's processes should be consistent. Are congressional processes consistent across the organization? The House has different rules from the Senate and the two legislative bodies were intended to behave differently by the framers of the Constitution. So in this respect, application of CMMI® "Defined" processes across both House and Senate could have a negative effect upon the checks and balances in the system.

Would the law making process in Congress benefit from more detail and more rigorous performance of the processes? By being more detailed and more rigorous, would information about improvement of Congressional processes be easier to understand? Or would more details and more rigors be counterproductive? Would Congressional action be even slower than it is today? One can make the case that the process is already so detailed and rigorous that Level 3 definition has been reached and the impact has not improved speed or quality of the actions taken.

This brings us to the CMMI® Level 4 of Quantitatively Managed processes. At this level, an organization's processes and procedures are controlled using statistical quantitative techniques. As a result, future performance can be predicted. A Level 4 organization, using statistical analysis, repeatable, well-defined and managed processes, can set quantitative objectives for quality and process performance with reasonable probability of achieving these goals. Management of the

processes, standards and procedures is performed continuously. People in the organization performing the process are directly involved in the quantitative management. Causes of variation are identified and addressed (CMMI, 2002).

In our Congressional process flow example, we do not see any evidence of the application of statistical quantitative techniques to control the law making process. There are no observable quantitative objectives for quality of the laws produced or the process performance and there is no management of any quantitative analysis throughout the life of the process. Neither Senators nor Representatives conduct any quantitative management of the Congressional processes. Causes of variations, such as failures to pass budgets in a timely manner, are not identified or addressed and relevant stakeholders, such as voters, don't have a quantitative understanding of, and have not agreed to these performance shortfalls. It is clear that Congressional activities of the law making process do not meet the criteria for CMMI® Level 4.

Since the criteria for CMMI® Level 5 are inclusive of the Level 4 criteria, it is also clear that the Congressional law making processes cannot be certified to meet the Level 5 definition of 'Optimized' capabilities. In addition to application of the quantitative measures described at Level 4, what would need to be done to optimize the law making process? Congress would need to be able to change and adapt processes to meet relevant current and projected objectives.

Currently, processes can be changed but not very quickly and not in a timely manner to address current objectives. Continuous improvements to address root causes of process problems identified by quantitative analysis would need to be implemented. Cost and impact analysis of the identified improvements would be need to be weighed against the potential contributions to processes and procedures. Systematic management of these continuous process improvement changes would need to be in place (CMMI, 2002).

CONCLUSION

While many diverse organizations applying CMMI® have demonstrated improved performance in categories including cost, schedule, productivity, quality, and customer satisfaction, can application of the CMMI® framework and bodies of knowledge to the process of lawmaking yield improvements?

Other than death and taxes, change is the only constant in life. How do you manage change especially in relation to law making? How do we know if change in the legal system is being managed well? How do we monitor progress? How do poor law making processes impact safety, reliability, efficiency and effectiveness (Caralli et al., 2012)? A capability level consists of a generic goal which is related to practices, processes, standards and procedures. As generic goals are satisfied by generic practices at each level, benefits of process improvement should be achieved (CMMI, 2006).

Potentially, improved processes and procedures would ensure assignment of resources with adequate funding, responsibility and authority to improve laws with increased involvement of all relevant stakeholders. Objective and quantitative measurements of the law making process would add predictability and support for consistent corrective actions.

Expanded training for law makers on how to perform quantitative analysis and how to contribute to the process of improvement would build positive feedback and performance awareness into the system. Systematic management of process changes would help inform the electorate and may result in improved quality of the resulting laws.

However, as we have seen in this high level evaluation, current law making processes in the US could be assessed at CMMI® Level 2 or possibly Level 3. Many organizations have found that implementation of changes required to achieve CMMI® Levels 4 and 5 may be feasible but not economical. Corporate governance critics cite focus on conformance and compliance over value creation and performance – would that be a drawback to a CMMI® application to Lawmaking? A balanced approach to conformance and performance would be needed. Brand, et al. (2011) suggest a meta framework for corporate governance to try to achieve this goal; perhaps such an analysis is needed for law making as well.

Would the higher levels of process control and analysis involved be flexible enough to support the legal discipline? Sometimes the subjective nature of laws allows for changing interpretations over time that meet stakeholder needs as culture evolves. Would lobbyists and special interest groups yield influence and control to objective and quantitative analysis of laws? Would there be benefits to improving the capability maturity level of our law making processes? Absolutely, but can we get there? Only if there is the political will to do so.

REFERENCES

Blackwell, C., Athenian Democracy: a brief overview, *The Stoa: a consortium for electronic publication in the humanities*, 2003

Brand, N., Beens, B., Vuuregge, E., Batenburg, R. Engineering governance: introducing a governance meta framework, *International Journal of Corporate Governance*: 2011, 2(2), 106-118

Caralli, R., Knight, M., Montgomery, A., Maturity Models 101: A Primer for Applying Maturity Models to Smart Grid Security, Resilience, and Interoperability, SEI, 2012

CMMI Product Team, Capability Maturity Model Integration (CMMISM), Version 1.1, Carnegie Mellon Software Engineering Institute, Pittsburgh, PA, 2002

CMMI, CMMI for development, Carnegie Mellon Software Engineering Institute, Pittsburgh, PA, 2006

Danziger, D., Gillingham, J., *1215 the year of Magna Carta*, Hodder Paperbacks, 2004

Garcia, Suzanne, Turner, Richard, *CMMI Survival Guide: just enough process improvement*, Pearson Education, Inc, 2007

House of Representatives, Congress Profiles, retrieved 10/01/2015 from www.history.house.gov/Congressional-Overview/Profiles/1st

Library of Congress, All bill information (except text) for H.R. 5739 – No Social Security for Nazis Act, retrieved 10/01/2015 from https://www.congress.gov/bill/113th-congress/house-bill/5739/all-info

Sarbanes-Oxley, H.R. 3763 the Sarbanes-Oxley Act of 2002, US Government Printing Office, 2002, retrieved 10/15/2015 from https://www.gpo.gov/fdsys/pkg/BILLS-107hr3763enr/pdf/BILLS-107hr3763enr.pdf

Williamson, C., *The laws of the Roman people: public law in the expansion and decline of the Roman Republic*, University of Michigan, Ann Arbor, 2005

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Environmental Laws vs. Laws of Nature: Using Enterprise Architecture to Model the Balance of these Systems

Josette Rice*

ABSTRACT

Environmental protection laws have become complex and far reaching, impacting every aspect of our lives, sometimes to the extent of great inconvenience and annoyance. Nevertheless, we have learned to appreciate them because we have experienced remarkable improvements in the air we breathe, the water we drink, and the environment we live in. The intent of environmental laws is to protect our natural resources, and for the most part, this has been the outcome. But have we gone too far in some cases? Have some environmental laws gotten so complex they have become conflictive and ineffective? Is there a limit to what we can do to save the planet?

The EA is a structured and scientific approach to tackle complex problems and develop long term solutions. This presentation shows how the EA approach using information modeling can address these issues head-on and manage the problems and conflicts that arise when we are doing our utmost to protect our natural resources and simultaneously achieve a happy balance with everything else.

A powerful case study will illustrate the impacts of environmental laws that are showing signs of having outlived their usefulness and will likely need to change or eventually be overcome by the laws of nature.

Keywords: enterprise architecture, information reference model, environmental laws.

INTRODUCTION

John Arbuthnot said "Law is a bottomless pit; it is a cormorant, a harpy that devours everything." This satirical statement criticizing politics in 18th century England may have expressed Arbuthnot's frustration with the impact of laws on his life. Punishment for crimes, during this time, was based on a catch all approach which usually resulted in being sentenced to death. Not until later in the 18th century did the English legal system began to take a role in the prosecution of criminals, which had previously been done by the victim. The punishment by death approach was modified to now include various degrees of punishment based on severity of the crime. Although some improvement to English law took place then, there remained many laws on the books based on superstition and religious beliefs. For example, there were laws making witchcraft a crime, punishable by death, even into 18th Century England [1, 2].

English law formed the precedence of most of the early colonial laws in America, including laws based on superstition. For instance, witchcraft was still a crime punishable by death as documented by the Salem Massachusetts Witch Trials of 1692 [1].

IDEAL LAW OF GOVERNMENT-LEVELS OF EFFECTIVENESS

Today the lawmaking process is based on the traditional method of making laws, which fails to link laws to problems that need solving. Developing effective and relevant laws requires defining the problem upfront and applying the scientific method for developing laws that actually solve societal problems. The Ideal Law of Government provides measures of effectiveness that can guide us towards making laws that are of the highest quality. The Ideal Law of Government has the following characteristics: 1) is simply stated and has a clear meaning; 2) is completely successful in achieving its problem-solving objective; 3) interacts synergistically with other laws; 4) produces no detrimental side effects; and 5) optimally serves the purpose of democracy. These five characteristics can be used to check against the intended outcome of a law as follows [3]:

1. A law must be enforced to have any relevance. If resources are not applied to enforce a law, it will go unnoticed and unattended and its objective will not be realized.

2. A law is reviewed usually only when its relevance is questioned or it is in conflict with other laws. This is why we have a court system, where laws can be questioned and reviewed and laws can be scrutinized when they come in conflict with each other.

3. Laws affect every aspect of our lives. This is why we have representation of the people and why we have the Constitution.

The goal of this study is to apply the concepts of Ideal Law, systems engineering principles, and tools of Enterprise Architecture, to understand environmental protection laws, their complexities, relevance, and their impact on the environment. We selected our case study for the following reasons: 1) to show how the principles of Ideal Law can be applied to solve problems in a complex system 2) to show how and why we apply the EA framework and Information Reference Model to a complex system; 3) to capture the elements of the system that are critical to understanding the problem; and 4) define the boundaries of the problem that can provide insight into developing sustainable solutions.

ENTERPRISE ARCHITECTURE FRAMEWORK

Enterprise Architecture is a structured approach to identify, analyze, and model outcomes and factors that affect a system or enterprise. The overall goal is to improve efficiencies, reduce costs, increase scalability and agility, and standardize products and services. The EA process provides end-to-end management over the entire lifecycle of the enterprise. EA is used to depict the relationships and dependencies of a system or multiple related systems and to understand and solve complex problems. The objective is to develop clear, measurable, and achievable success criteria based on "Best Practice" standards. EA provides a methodology to:

1. Identify problems, mission objectives, and capabilities.
2. Develop an architecture that follows a structured and scientific approach to designing and implementing a successful solution.
3. Eliminate waste and duplication, increase shared services, close capability and performance gaps.
4. Build a roadmap for improving the return on investment.
In this case, we want to be able to use the EA approach to implement and manage the life-cycle of effective laws.

Enterprise Architecture provides guidance for the selection of solutions to support the life-cycle of a system. The process of lawmaking can be modeled as an enterprise. For example, EA can be applied in the case of putting a new law into motion or reviewing and revising an existing law. The process of law making can also be treated as a complex system of systems, whereby multiple related laws can be viewed and analyzed to make up new laws or make improvements to existing laws that will impact one or more of the other related laws. The EA lifecycle processes are mapped to the process of law making in Figure 1.

Concept Exploration: developing an idea of a new law or revising an existing law. Here is where the problem the law is solving is described along with rationale as to why the law should be enacted or revised.

Research and Development: preparing and formally presenting a proposed law. Here is where a bill or proposition will be evaluated and analyzed and where the design requirements and rational of the proposed law are developed in detail.

Testing - Verification and Acceptance: the proposed law is voted on and approved. Verification and acceptance is the process of proving the law meets its design requirements. Did we make the right law?

Fielding - Validation and Deployment: the bill or proposition becomes a statute. Validation is the process of assessing whether or not the requirements of the law clearly, completely, correctly, and consistently are understood. Did we define the right law to be made?

Operations and maintenance: Resources are allocated to enforce the law. Here is where the effectiveness of the law is observed and recorded. Documentation of the outcome of the law would provide valuable information during a review and revision process.

Sustainment - Changes, Upgrades, Process Improvement: The law is reviewed for relevance and changes are proposed to improve the law if necessary.

Retirement or Replacement: validation is revisited and outcome of the law is reviewed. The law may be revised or upgraded to maintain its relevance. If the law can't be upgraded to stay relevant, it may have reached its end of life and it is formally retired.

Figure 1. Mapping of Systems Engineering Life-cycle to the Process of Law making.

RELEVANCY OF A LAW

The intent of every law should be to satisfy the Ideal Law of Government. When a law becomes obsolete it should be removed from the code of law. This does not always happen for various reasons, possibly because no one is breaking that law, or it is not being enforced, or more likely, the law has simply become irrelevant and has gone ignored, yet it can remain in the code of law for decades. Here are some examples of laws that may be excellent candidates for review.

1. It's against the law to catch fish with your bare hands in Kansas.
2. In Utah, it is illegal to swear in front of a dead person.
3. Driving more than 2,000 sheep at a time down Hollywood Blvd. is prohibited by law.
4. You can't plow a cotton field with an elephant in North Carolina.
5. In Georgia, US, members of the State Assembly cannot be ticketed for speeding while the State Assembly is in session.
6. In Cleveland, Ohio it is illegal to catch mice without a hunting license.
7. In Kentucky, it is illegal to carry ice-cream in your back pocket.
8. It is illegal to hunt camels in the state of Arizona.
9. In Pennsylvania, it is illegal for a man to purchase alcohol without written consent from his wife.
10. In Miami, it is forbidden to imitate an animal.
11. Alaska law says that you can't look at a moose from an airplane.

APPLYING THE EA FRAMEWORK

EA is used by organizations to aid in reliable planning and decision making across all program and service areas. Within a complex system of systems, there are many intertwined and interconnected subsystems that need to be identified along with their interfaces, relationships, and dependencies. Stakeholders need to be identified and managed. Standardization of elements and common understanding of terms needs to be developed to ensure effective communication between all stakeholders. New processes and procedures must be put into place and new processes must be integrated with the existing processes and procedures, to implement efficiencies wherever possible.

The complexity of cost, schedule, scope, risk, and quality must be identified and spread across multiple projects and organizations. Cost, schedule, and scope can be optimized through every phase of the life-cycle of a system by applying a standardized process of estimating, tracking, and project controls. Risks can be minimized by improving project transparency, specifying standardized approaches, and describing the corresponding results and responsible roles. Quality can be managed by ensuring that the products provided are complete and meet the requirements.

INFORMATION REFERENCE (IR) MODEL

The IR model is a scientific view of the problem space, containing all the components necessary to identify and analyze the problem. It is a logical approach to capture the information and processes needed to understand the problem. The IR Model is a tool that aids decision making that can lead to a solution set. For example, the IR model can be used for simulation and reporting capabilities to track and manage the impact of a new law.

The Information Reference (IR) model supports the EA framework by providing a view of key entities, their relationships, activities, roles, responsibilities, and interdependencies (Figure 2). The IR model is used to facilitate development, interoperability and compatibility between entities. All aspects of a system's functionality and configuration can be identified and documented in the IR model, such as strategic drivers, requirements, applicable standards, workflow processes, and information exchanges.

IR is developed early in the life-cycle of a system to identify goals, mission objectives, and operational concepts, and aids in planning, managing, implementing, and executing processes.

USES FOR THE IR MODEL

The IR model describes entities and their relationships, and how they connect and interact with one another. The IR model can be used to create standards for objects that behave according to that standard. For example, a law can be written that meets a standard, and developers can copy this law and use it again, or craft another law that achieves the same quality. A standard can make use of other design criteria that support key qualities of the law, such as the ability to get the law approved quicker and at lower cost.

Another use of the IR model is to educate. Using the IR model, developers can make the problem less complex by breaking down a large problem space into smaller problems that can be understood, tackled, and refined.

The IR model can be used to improve communication between people by breaking up a problem into individual entities or smaller groups having similar characteristics. The IR model is useful by defining how concepts differ from, and relate to, one another.

The IR model can be used to create clear roles and responsibilities. By creating a model of entities and their relationships, an organization can dedicate specific individuals or teams, making them responsible for solving a problem that concerns a specific set of entities.

The IR model allows the comparison of different things. By breaking up a problem space into basic concepts, the IR model can be used to examine two different solutions to that problem. In doing so, the component parts of a solution can be discussed in relation to one another. For example, if the IR model describes a system of products or services that protect the environment, then the IR model can be used to decide which of these products or services best meets the needs.

INFORMATION REFERENCE MODEL DOMAINS (VIEWS)

The IR model has three domains or views: Strategic View, Operational View, and System View.

1. The Strategic View is used to identify, goals, objectives, and capabilities; and identify, understand and manage problems. It consists of Vision, Capabilities, Program/Project Management (Stakeholder Identification,

Project Charter, Project Plans), and Analyses to include, Business Case Analysis (BCA), Analysis of Alternative (AoA), and Risk.

2. The Operational View consists of Missions, such as, Use Cases, Activities, Actors), and Decision Support.

3. The System View consists of functions, requirements, standards, constraints, best practices, interfaces, logical entities, and verification and validation.
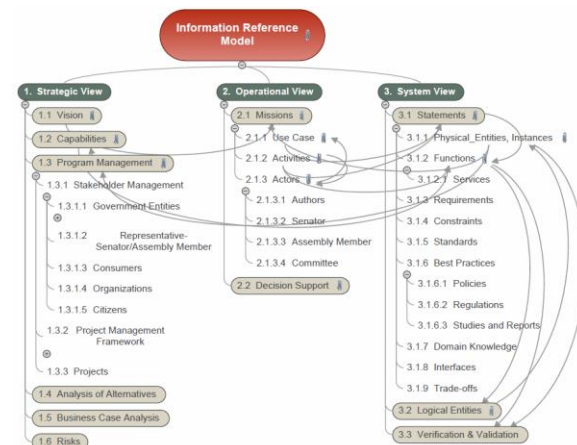

Figure 2. Information Reference Model

The IR Model views can be used to organize the components of a new law or revise an existing law.

The IR Model facilitates planning, managing, implementing, and executing processes and developing and maintaining common understanding of the system. It is also scalable to changing requirements.

The IR model aids in development of a Decision Support System (DSS) to facilitate assessment of feasibility. For example, for modeling, simulation and reporting capabilities to track and manage the impact of a new law or modifying and existing law.

The IR Model is a powerful tool for tracking product development (quality control) and process improvement (quality assurance) and can be used to reduce complexity, quantify risk, and predict outcomes.

CASE STUDY: TIJUANA RIVER VALLEY

The Tijuana River Valley (TJRV) contains the Tijuana Slough National Wildlife Refuge, one of California's largest remaining salt marshes without a road running through it. Surrounded by San Diego county and Tijuana, Mexico, it provides critical habitat for endangered birds, such as, the California least tern, Light-footed Rail, and Western Snowy Plover. Over 370 species of birds have been sighted on the refuge in this part of the Pacific Flyway – that is more than 2/3 seen in North America.

The Tijuana River Valley today is a thriving rural community containing 71.5 miles of dirt roads, paths, beaches, and parks. It is home to horse stables, farmers, residential, community gardens, bird and butterfly gardens, and private businesses.
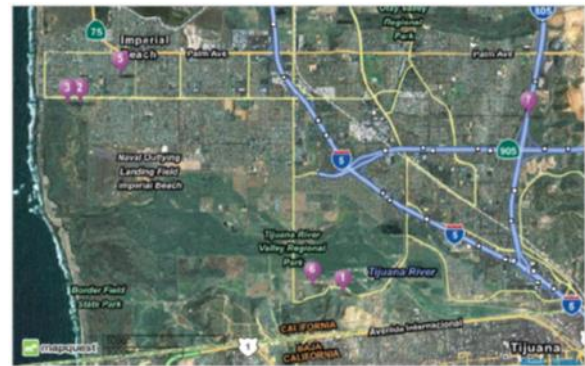

Figure 3. Tijuana River Valley and Vicinity

The Refuge itself, is 2,521 Acres, governed by US Fish and Wildlife Service and part of a larger unit called the Tijuana River National Estuarine Research Reserve, administered by the National Oceanographic and Atmospheric Administration (NOAA).


Figure 4. Goat Canyon in Tijuana River Valley

HISTORY OF TIJUANA RIVER VALLEY

The Tijuana River Valley (TJRV) has a rich and diverse history. Human beings may have arrived as early as 40,000 years ago (Late Pleistocene era), when much of the Earth's water was trapped in ice sheets. The estuary was a river-bottom land thick with trees and shrubs. The kelp beds to the west provided sardines, tuna and shellfish. As the polar ice melted, the sea level rose and flooded coastal valleys.

As centuries passed, the climate became drier. The trees and grasslands receded. Drought-tolerant scrub and chaparral spread over the uplands and salt-tolerant species took over the expanding marshes. Today the TJRV is populated by a diverse species of native plants and protected wildlife.
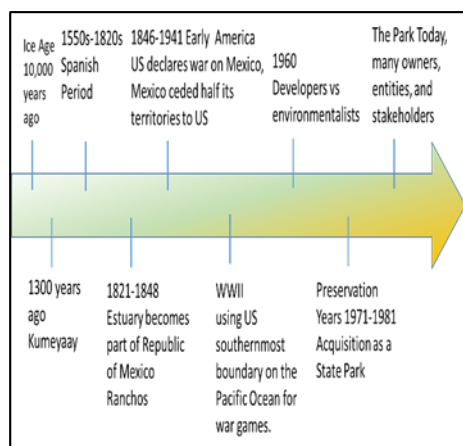
Figure 5. History of the Tijuana River Valley

As centuries passed, the climate became drier. The trees and grasslands receded. Drought-tolerant scrub and chaparral spread over the uplands and salt-tolerant species took over the expanding marshes. Today the TRV is populated by a diverse species of native plants and protected wildlife.

During the 19th Century, many farms and ranches were established, much of the TJRV became privately owned by ranchers and farmers.

The early Twentieth Century brought thousands of immigrants from Mexico during the Mexican Revolution, along with new residents, businesses, tourists, and developers. In 1904 the Border Patrol was established to stem the flow of Chinese laborers who were entering the U.S. through Mexico. In 1909 Imperial Beach was established as a summer retreat for residents of Imperial Valley.

With the onset of WWII, The U.S. Navy leased 245 acres along the border and established Border Field Auxiliary Landing Field — an operation that included thirty-five buildings, one barracks, a galley and a machine-gun range. In 1955 the Navy began operating a helicopter landing field, the home base for all helicopter squadrons of the Pacific Fleet. Today the landing field is used as a helicopter training airfield.

In the 1960s developers actively lobbied the Federal government and local landowners with a plan to create an upscale marina in the estuary. In 1980 Residents of Imperial Beach voted in favor of the marina project. Nevertheless, that same year, the U.S. Fish and Wildlife Service purchased the northern 500 acres of the estuary from the Helix land company and established the Tijuana Slough National Wildlife Refuge.

In 1982, in spite of heated opposition from developers, both State Park and National Wildlife Refuge land became part of the U.S. Department of Commerce's National Estuarine Sanctuary Program, and designated a National Estuarine Research Reserve.

Into the 80s' and 90's even though Border Field State Park and National Wildlife Refuge land represented a sizeable chunk of land, the majority of the Tijuana River valley and estuary was, unfortunately, still unprotected. Upstream in Mexico, Tijuana was filled with impoverished squatters, makeshift commercial activities, and auto dismantlers. There was no infrastructure, nothing to prevent sewage and other waste from flowing from these settlements right into the river and across the border into the estuary and out to sea. Intermittent flooding carried excessive quantities of garbage, construction materials, tires, and sewage right through the river valley.

The city of Tijuana is about 300 feet higher than Imperial Beach. During the wet season, usually November through April, pollutants wash down through the urban canyons in the outskirts of Tijuana. In these canyons, tens of thousands of people live in ramshackle villages called Colonia's. The population in Tijuana grows every day. In 1980, there were 500,000 people, and by 2013, the population rose to more than 2,500,000, much of whom were not hooked up to sewer lines. The population explosion was fueled by jobs at the maquiladora plants, which thrived after the US ratified the North American Free Trade Agreement. This explosive growth caused significant pollution. For instance, rain from a December 17, 2008 storm caused the river to spew an estimated 3 billion gallons of contaminated water into the Pacific Ocean in one 24-hour period.

Figure 6. The Tijuana River Water Shed

Adding to the pollution problem is the unpredictability of Mother Nature, determined to flood, promote overgrowing of vegetation, and create easy flow for sedimentation during storm events that is smothering the salt marshes. To add to the problem of devastation of the TJRV, more than 70,000 trees have been infested with the Kuroshio shot bore beetle. Many of the dead or dying trees are native willows.

HIGHLIGHTS OF ENVIRONMENTAL PROTECTION LAWS AND LEGISLATION-LEVERAGING THE LEGISLATIVE PROCESS

California voters approved money for Border Field's acquisition as a state park in a 1964 Bond Act. This served as a big blow to the developers who wanted to build a marina and dredge the Tijuana River.

In his Environmental Address of February 1971, President Richard Nixon announced Border Field be developed for recreational use as part of his "Legacy of Parks" program. Three hundred seventy-two acres became part of Border Field State Park. During this time, Local biologists Joy Zedler and Paul Jorgensen, along with Dr. Mike McCoy, a wildlife veterinarian, organized local environmentalists and Imperial Beach residents to support the estuary's preservation.

The passage and enforcement of many environmental protection laws played a significant role in setting the precedence for enforcement of environmental protection laws. Laws such as 1) the Clean Air Act (1970); 2) Clean Water Act (1972) – amended several times, most prominently in 1987 to increase controls on toxic pollutants, and in 1990, to more effectively address the hazard of oil spills; 3) Coastal Zone Management Act (1972) that provides a partnership structure allowing states and the federal government to work together for the protection of U.S. coastal zones from environmentally harmful overdevelopment; and 4) Endangered Species Act (1973) designed to protect and recover endangered and threatened species of fish, wildlife and plants in the United States and beyond.

Environmentalists could now use these protection laws to prevent efforts to turn the Tijuana River into a concrete channel.

NATURE'S INFLUENCE ON HOW WE BEHAVE

In 1916 E.S. Babcock, builder of the Hotel del Coronado, dredged a channel from the bay to the north end of Tenth Street in Imperial Beach to ferry tourists from downtown San Diego to the "South Bay Landing." During the flood of 1916 this channel filled with silt and was never re-dredged.

In 1980, the City of Imperial Beach decided to put the construction of a new marina to a vote. A fierce December storm flooded the river valley and estuary. At the election, Imperial Beach residents voted in favor of a marina over those in favor of the estuary's preservation.

ENVIRONMENTAL LAWS IN CONFLICT WITH LAWS OF NATURE

Nature keeps coming back with a vengeance to change the landscape. Storm water continues to bring substantial amounts of sediment and trash and other contaminants into the Valley from sources on both sides of the United States and Mexican border.

For instance, in Dec 2008 the rain-swollen Tijuana River breached its banks just north of the Mexico line, and inundated the surrounding Tijuana River valley. Lifeguards and firefighters rescued two dozen people – six of whom were extricated by helicopter. Forty horses were rescued from the floodwaters. Sadly, three horses drowned in the trash-laden stormwater.

Figure 7. December 2008 TJRV flood (unknown Photographer)

ENVIRONMENTAL LAWS IN CONFLICT WITH EACH OTHER

Most environmental programs have been delegated by the Federal Government down to the state Government departments who have the responsibility for administering environmental protection programs. The responsibility then flows down to the local principalities to enforce the laws. Complexity and conflict arises when environmental laws become intertwined with many entities and stakeholders. For instance, conflicts in the municipal codes and enforcement policies often arise between city, county, State, and Federal Environmental Protection agencies. Conflicts can get caught up in litigation and the courts, for months and sometimes for years. For instance, a farmer, who owned about 10 acres in the TJRV, wanted to import a foot of new soil on his parcel. This required about 2000 cubic yards of clean dirt. Because the farm was located in the flood zone of the TJRV, the farmer was not allowed to spread the soil on his land. Another rule allowed the farmer to spread the soil because he was a farmer as was the case for all the farmers located in the flood zone. This case was in litigation for several months at the City of San Diego Code Enforcement department. Even if a waiver is requested it can take even longer for a decision. It is at the local level where the conflicts of these laws have their greatest impact.

Conflicts in laws can also arise between international boundaries, such as, between the United States and Mexico. Although, Mexico and the US have agreed on many

strategies and potential solutions to reduce the impact of debris and sewage flowing into Tijuana River watershed, resources have been limited and continue to be an ever increasing challenge.

WHO'S RESPONSIBLE?

The Tijuana River valley has decades of water pollution issues. Thousands of acres have been degraded due to excessive sedimentation and trash generation from both U.S. and Mexico. Excavation and exporting debris from the region is barely containing the problem of devastation to the Valley. Because of its proximity to the border and the fact that the Tijuana River and most of its tributaries flow from Mexico, we will need to understand Mexico's problems and limitations they face in their ability to support viable solutions.

Agreements and partnerships have led to some improvements to the TJRV. For instance, in 2005 a sediment basin system was built in Goat Canyon by the California State Parks and Recreation department in effort to keep sediment and trash material from entering the estuary. In addition, significant improvements in wastewater treatment in recent years have improved water quality on both sides of the border.

INFORMATION REFERENCE MODEL APPROACH TO TJRV CASE STUDY STRATEGIC VIEW

The Strategic View of the IR model can be used to understand problems and find solutions that achieve the vision of a healthy Tijuana River Watershed. The California-Baja California 2020 Plan outlines a strategy for resolving sediment and trash problems in partnership between the U.S. and Mexico. The Plan is to identify projects to reduce trash and sediment in the Tijuana River, dispose trash that has been separated from sediment captured in the Goat Canyon Sediment basins, remove trash from Goat Canyon Sediment basins after significant storm events, and haul debris to landfill. These projects are funded by EPA, State of CA, NOAA, and Mexico.

The Vision is to allow a way for stakeholders, policy makers, and potential funding sources to have a clear understanding of both the problems and the solutions and help to achieve the vision of a healthy Tijuana River Watershed in a manner that is acceptable to the communities on both sides of the Unite States and Mexico border.

The capabilities will include source control and pollution prevention activities which are currently the most economically feasible long-term solutions to sediment and trash and other water quality problems.

The Program Management component if the IR model identifies stakeholders, their relationships to each other, and to other components of the IR model (see Figure 8). Major stakeholders include: California Department of Parks and

Recreation, US Department of Homeland Security and Border Patrol, Tijuana River National Estuarine Research Reserve, California Department of Fish and Wildlife (CDFW), City of San Diego, City of Imperial Beach, County of San Diego, Residents – farmers, horse ranchers, community gardens, Businesses –Nurseries, Farms, Public – (horseback riders, hikers, surfers, park visitors), Mexico, and of course, Mother Nature!

Figure 8. Strategic Domain of the IR model

Program Management is responsible for managing Cost, Schedule, Scope, Risk, and Quality across multiple projects and organizations. The objective of these projects is to plan and carry out their mission of reducing the flow of sediment and trash and helping to solve other water quality problems in the TJRV.

The Business Case Analysis and Analysis of Alternatives focus on source control and pollution prevention activities that offer the best and most economical solutions.

OPERATIONAL VIEW

The Operational View is shown in Figure 9. The missions and statements (standards, constraints,) help understand the interdependencies and interfaces that arise during the development of the model. Projects are implemented that focus on successfully reducing the sediment and trash. US will partner with Mexico to implement optimum, watershed-based solutions, understand how water, sediment and trash flow, and identify methods and technologies that can reduce sources of sediment and trash. Ongoing operations will perform maintenance (O&M). The program involves and informing the community in Mexico and United States on measures to protect and enhance natural resources.
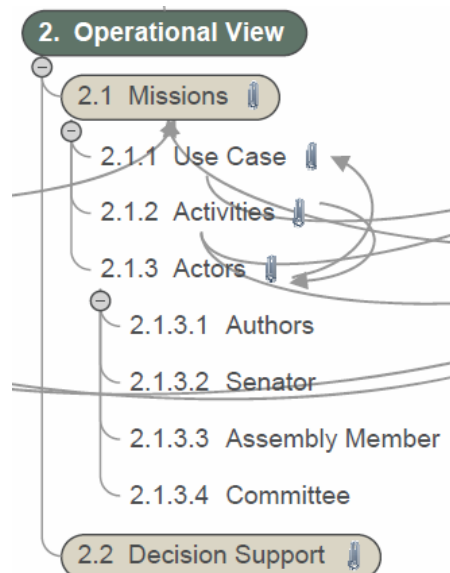
Figure 9. Operational Domain of the IR model

SYSTEM VIEW

System components of the California-Baja California 2020 Plan are mapped to the System View (see Figure 10).

For example, a resolution to the sediment and trash problem requiring partnerships is a high level requirement that can be organized and broken down into smaller components, such as, services, agreements, and best practices. All requirements and constraints can be managed throughout the process of unfolding and managing problems and their interfaces, relationships, and dependencies to each other.

The system view can aid in implementing and integrating processes, standards and policies.

CONCLUSION

When we apply the concepts of Ideal Law, systems engineering principles, and the Information Reference model of Enterprise Architecture to the process of law-making, we have a much clearer picture of complexities, relevance, and impact of laws. We can more easily identify and understand the problems and conflicts that arise among stakeholders. By having a clear understanding the problems that created the conflicts we can build pathways to long term solutions.
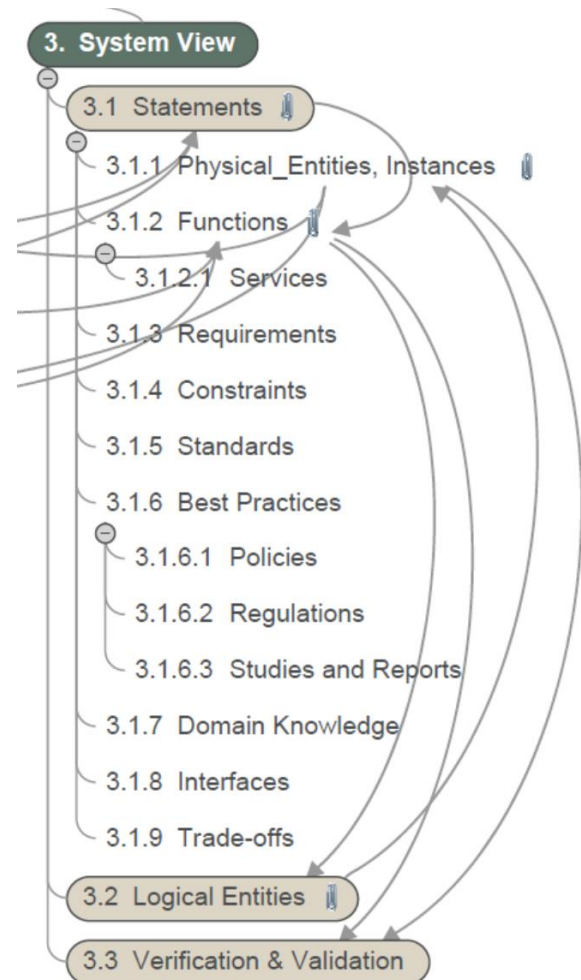
Figure 10. Systems Domain of the IR model

REFERENCS AND ADDITIONAL READING

1. American Law: History & Origins from English Common Law:
   http://study.com/academy/lesson/american-law-history-origins-from-english-common-law.html
2. *The Formation of the English Common Law: Law and Society in England from the Norman Conquest to Magna Carta*, London, 1992, 2nd edn, Cambridge.
3. Ideal Law of Government – The Science of Laws Institute, http://www.scienceoflaws.org/quality-laws/ideal-law-of-government.aspx.

4. FEA Consolidated Reference Model Document. Federal Enterprise Architecture Framework version 2 January 29, 2103.
5. A Common Approach to Federal Enterprise Architecture, 2 May, 2012, Federation of EA Professional Organizations.
6. "Common Perspectives on Enterprise Architecture" *Architecture and Governance Magazine*, Issue 9-4, November 2013 (2013).
7. History of the TJRV: http://trnerr.org/wp-content/uploads/2010/12/hs_curriculum_HISTORY-chapter.pdf
8. California-Baja California 2020 Action Plan: http://www.calepa.ca.gov/Border/CMBRC/2016/CABaja Plan.pdf

Josette Rice is President and founder of Chigosi Company. She has 35 years of experience spanning the defense and commercial industries. Ms. Rice's background represents a complement of experience in program and project management, engineering, construction management, contract management, and business management.

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