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Policy Informatics v1.0

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Abstract

The reality of public policy is that it advantages some and disadvantages others at local, community and individual levels. Decision makers and policy analysts face a constant influx of information, conflicting values and political pressures. There is a growing need for navigating the vast amounts of complex information effectively, for identifying patterns, for building justifications, for ensuring transparency of influences, and for accounting for uncertainty and risk. Many policy-related activities such as determining options, evaluating alternative scenarios, setting strategies, and monitoring consequences have been pivotal issues in maintaining sustainable localities, communities, and nation in this rapidly changing environment. If we can effectively extract the useful patterns of complex policy landscapes, policy debates can be much more informed and inclusive, thus yielding more widely-accepted decisions that will thoughtfully guide the future of our communities. The formalization of research methods and theory of Policy Informatics will help guide the future of the research and practitioner communities of governance.

Keywords: Policy Informatics; Governance; Modeling

Introduction

One of most significant societal changes we observe today is an explosion of data and the technologies to process that data. Computers, storage, and displays are becoming less expensive, data networks are expanding in capacity and scope, and computational and visualization power at our disposal is increasing. Even before we fully understand the implication of yesterday's information and technology to public organizations, we are experiencing a new generation of IT such as the contributive internet of Web 2.0, advanced pattern matching, and a wide variety of communication technologies including wikis and the blogosphere. What does this mean for research and practice of public administration and policy? In this paper, we argue that we now have the ability to use these technologies to move beyond information processing and to change the policy conversation to focus on substantive debate, but we need to better exploit the potential of developing computational tools and techniques in understanding and addressing complex policy problems.

In recent years, society-wide trends in informatics enable us to operationalize old but crucial concepts for researchers and practitioners. This has been possible thanks to the decreased cost and increased availability of communication networks, improved computational power, and the reorientation from *organizations* to *problems* as the focal unit of work (Malone, 2004). Novelty and technical advances in society accompany new knowledge and challenges. In particular, its implication to how we approach governance (or policy questions) in both research and practice is significant.

In the conclusion of the special issue of *Public Administration Review* on collaborative public management, Bingham and O'Leary (2006) well stated what we hope to deliver in this paper:

> *To borrow another metaphor from Donald F. Kettl, we must establish boundaries and fences, but where? … We argue here that we have misplaced some of the fence. The question is not the scope of our field. … As an applied discipline that is focused on the work of serving the public, we have a defined mission, but we can and should draw from any body of theory and scholarship; thus, we have access to infinite space (p. 161).*

To achieve the mission of "the work of serving the public," we argue that a higher-order framework needs to be built not only for theory, but also for method which can be drawn from

advances in modern sciences. Current methodological standpoints in the field need to be updated. Policy informatics is a response to this outdated request.

We begin by defining what policy informatics is and how policy informatics is different from traditional approaches in public affairs. In the next section, we further clarify some of the theoretical foundations of policy informatics. Through an exploration of each field we will show that the current state of the field seems ready to evolve beyond traditional question. However, current governance debates remain at a descriptive level due to the gap between the evolution of governance and approaches available in the field. As such, we will explore emerging techniques as alternatives for governance research and how these techniques are changing what questions we can ask and how results can be presented. We then propose a concrete research agenda and future works in the areas of policy informatics to contribute to the body of knowledge and in practice.

What is Policy Informatics

Definition

We start with defining policy informatics as the use of tools, models, and simulations to aid individuals, groups, and communities to make policy choices, solve problems, and evaluate consequences. Although the concept itself is not a novel feature, the innovation being proposed here is two-fold: an advancement of the study of policy challenges and an advancement of the process of policy discussions.

We propose to synthesize several analytical tools and techniques to inform policy debates and thereby advance a new approach to handling the vast amounts of information and designing analytical tools to enable the patterned abstraction of complex policy landscapes. In doing so, we need a medium that allows us to communicate with various stakeholders through multiple channels because a community of decision makers consists of active, dynamic, and heterogeneous actors in networks. Developing such a mechanism or process has relative values compared to the approach relying on single analytical tool in the arena of policy analysis.

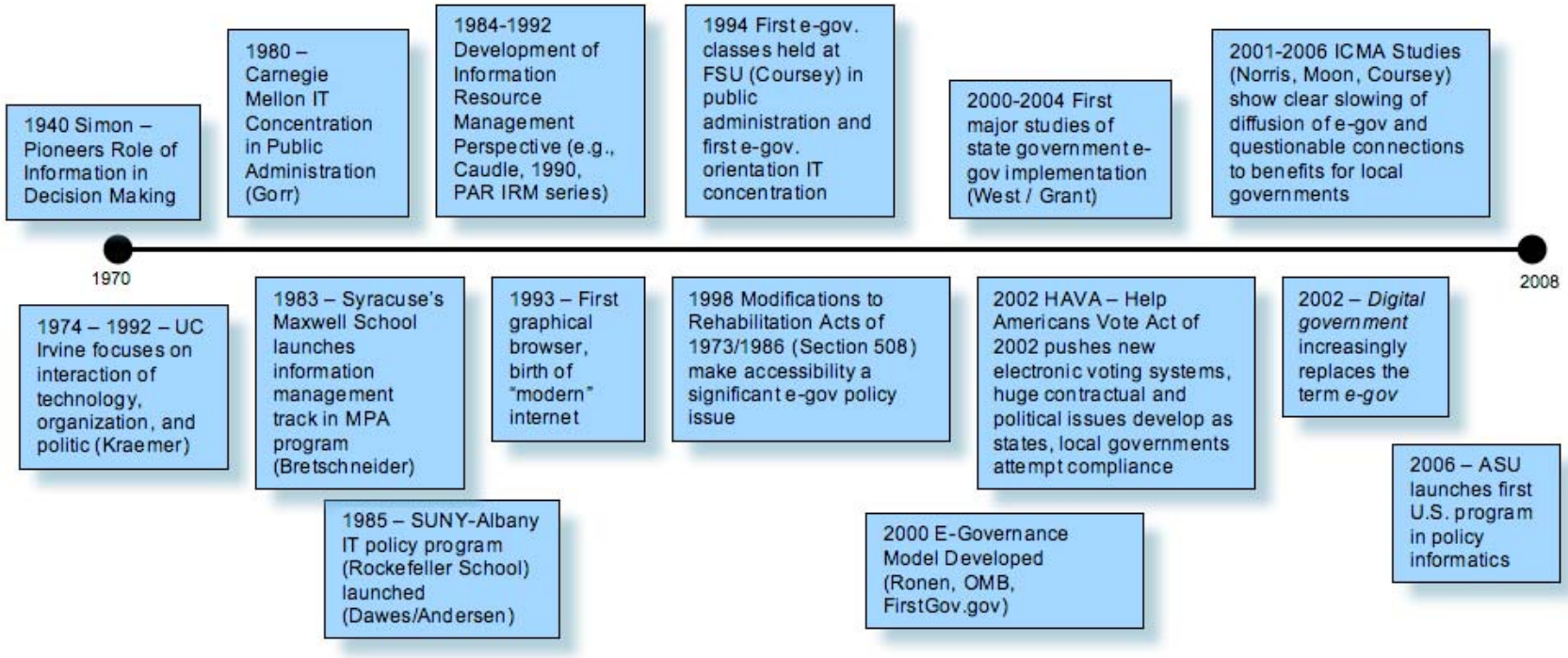
In the policy-making process, analysts armed with sophisticated tools form a small part of the

debate. Policies are made primarily by the interaction among diverse players with different interests at various levels. Solving problems usually involves managing the complementary influences of architecture design, policy choices, market forces, and social forces (Lessig, 2006). Traditional tools and techniques are as yet too context specific to incorporate and communicate different viewpoints and values in an interactive manner. Current advances in theory and models, immersive technology, and visualization tools provide enormous opportunities to contribute to governance by helping these players make collective decisions and actions as an active participant of the analysis rather than as a passive recipient.

Differentiation from Traditional Public Affairs

While history is relatively short, many have worked to explore the basic promise that information technology will significantly influence or can improve public affairs in research and practice. Since Simon (1957) argued that computer-based research can support the model of ‘administrative man’ with bounded rationality, significant academic activities have been initiated, developed, and advanced to understand and support decision-making in the pubic sector. The origin and development of policy informatics is summarized in Figure 1.

Figure 1: The Origin and Development of Policy Informatics



Perhaps the most significant differentiation of policy informatics from traditional approaches in public affairs is that we seek more actively to understand and fulfill the potential of interactive policy-making and co-production of policies *leveraging* the advances in modern information technology. In our reviews of theoretical foundations, we will explain the two crucial differentiation points of policy informatics in detail: evolution in understanding reality and computers as a legitimate source of knowledge generation. In developing this methodological standpoint, our ontological and epistemological bases have been open system views on complex worlds that do not easily reveal their nature for simplistic approaches and perspectives.

Theoretical Foundations

Academics is a cumulative science and policy informatics, like other sciences, is being built on the findings from other disciplines. In this section we will explore the influence on Policy Informatics of three current academic fields focusing on people, technology, and systems: Behavioral Economics, Management Information Systems/Decision Support Systems, and Complexity.

Behavioral Economics

Behavioral Economics is an interdisciplinary science at the intersection of economics, psychology, and cognitive science, each building on the groundbreaking and Nobel Prize winning work of Daniel Kahneman and Amos Tversky from the '70s. As a field it is framed on relaxing the economic assumptions of rational man, assuming that decisions of real people are predictably irrational (Ariely, 2008), and that these regularities can be understood. The regularities can occur in many stages of the decision process including setting up the problem (Gilbert, 2007), assigning accurate value to alternatives (Schwartz, 2005), appropriately factoring in risk, recognizing cognitive limitations (Anderson, 2004), and factoring in social influences. Taken together, decision themselves transition from static calculations to dynamic, complex systems.

Several tailored fields have recently developed as offshoots of behavioral economics including: *neuropsychology* (www.nanonline.org), *persuasive technologies* (Stanford,

captology.stanford.edu/index.html), and *incentive centered design* (Michigan, stiet.cms.si.umich.edu/icd). Findings in *neuropsychology* have shown, through the use of Functional MRIs, that different parts of the brain are more active depending on the types of decisions. For instance, when two parts of the brain are in conflict on what is the right course of action, areas of the brain responsible for regulating desire in the brain normally win out over the areas of the brain responsible for planning. *Persuasive technologies* look at how to design technologies to take advantage of our decision-making tendencies. For instance, one common finding is that humans spend a lot of energy to avoid the feeling of regret. To take advantage of this, many websites (e.g. amazon.com, woot.com) are designed to present regular, scarce items for purchase to entice repeated traffic to the website so people can avoid the feeling that they lost out on an opportunity. This is a simple example of how knowing common behavior regularities can lead to designs that influence behavior. *Incentive Centered Design* (ICD) is the science of designing systems to align individual incentives with larger social goals. Encouraging an individual to leave feedback on Amazon.com or rating movies on Netflix.com are examples of systems to help other customers gain confidence in the quality in their purchasing or find movies they would enjoy.

Each of these emerging academic areas first start with understanding the decision making process as a behavior. Recent advances in using behavioral economics as a policy aid include designing policy with behavior in mind. Brookings Institution, the National Bureau of Economic Research, and the Federal Trade Commission, all use findings from behavioral economics to guide the policy recommendations they make (Gandel, 2008). The goal is to find what Thaler and Sunstein (2008) calls a 'nudge point', or the place where small changes in policy design take advantage of the regular behavior of individuals and groups to create significant changes in outcomes. One simple example of such a recommendation includes switching individuals savings plans from opt-in to opt-out, preserving the same fundamental choice for the individuals, but increasing enrollment outcomes from 65% to 98% (Gandel, 2008). Both 2008 presidential candidates favor this emerging approach to policy design - motivated by findings from behavioral economics - in their plans on heath care, credit cards, retirement savings, and the environment.

Policy Informatics leverages the findings of behavioral economics both through study and service. In study, we find that that behavioral economics provides guidance in terms of grounding how to relax the rationality assumptions of our models. In service of policy decisions, policy informatics provides the foundation for model rules. Policy Informatics recognizes that decision making is a human activity constrained by individual and group limitations.

Management Information Systems/Decision Support Systems

Policy Informatics also shares many qualities with the Management Information Systems (MIS) field and especially with Decisions Support Systems (DSS). In the public sector, MIS was developed to put data in a context that is applicable to managers and to use computers to provide relevant information for organizational decision-making. The field has evolved from focusing on data processing in 1950-1960s to reporting information to managers in 1960-1970s, to building decision support systems in 1970-1980s, and to moving towards strategic and end-user support in 1980-1990s (Melitski, 2007). From definitions, we find a particular similarity of policy informatics with decision support systems. DSS has been defined as the use of computer based technology to assist managers in complex and unstructured tasks (Alavi, 1982). DSS is changing from a study aiming to aid individual decisions to helping corporate-wide systems and processes. The research is becoming more focused on organizational behaviors and their consequences. And the shift in the purpose of DSS is from making tools to assisting individuals use computers to making better decisions and thereby giving organizations a competitive advantage. Understanding the evolution of DSS over the last fifty years informs the relevancy of Policy Informatics today.

Similarly, since late in the 1990s, e-government has dominated the discussion of information technology in the public sector. With the e-government movement, public agencies started placing descriptive information in the websites (Census.gov, arizonaindicators.org) and further engaging citizens in an interactive manner (Robbins, Simonsen and Feldman, 2008). Researches have examined empirical evidence of the impact of e-government and concluded that e-government has fallen short of fulfilling its potential (Moon, 2002; West, 2004; Norris and Moon, 2005). Information technology has also played a role of supporting the implementation of public works, public service provision, and democracy. The applications of these efforts can be

found in workflow management, front end verification tools development, and transactions via internet (Snellen, 2005). While much of the previous work has focused on improving efficiency of public organizations using information technology, more radical trends are on the way. New technology such as Web 2.0, social networking, Youtube, blogging, wikis, and internet-enabled mobile phones are breaking down the barriers for participating in political debates and supervision and changing the fundamental way with which people communicate (Malone, 2004). The use of technology to increase transparency and citizen engagement for democracy is an imminent challenge to public organizations (Lessig, 2006).

Policy Informatics is similar to MIS/DSS in that both are focused on decision-making that is supplemented in some way by computer-based technologies. However, there are some significant differences. First, MIS/DSS has historically focused on improving specific processes within organizations. The goal of these process improvements has been to enhance efficiency, which is only one dimension of public organizations. For policy informatics, broader issues of effectiveness, governance, engagement, and outcomes are also of keen interest. These issues usually extend beyond the narrower need to improve organizational efficiency. A second significant difference can be found in the nature of the individuals involved. DSS deals with employees who are assumed to have similar goals within organizations. Policy informatics is interested in making sense of coordinating, collaborating, and cooperating players having different values, preferences, and capabilities, not only interest. These two differences present new research opportunities including focusing on collective actions using new technology, supporting the process instead of the content, and focusing on the issues instead of the decisions.

Complexity

Complexity science can be framed as the study of the phenomena which emerges from a collection of interacting objects (Johnson, 2007). In such complex systems, the objects (or actors) adapt their behavior to pursue their goals based on local rules. Due to the complex interactions, the self-organizing systems exhibit emergent phenomena. Emergence refers to “new system properties and relations among subsystems that has no place in the system components” (Simon, 1996, p. 170). An intense search is now under way for characteristics and rules associated with emergence across various complex systems. Everyday examples that complexity

science has studied include traffic jams, financial markets, weather, and ant foraging.

While its roots go much deeper (Goldstein, 1999; François, 1999), complexity science emerged as an academic activity in the US in the 1970s. The multidisciplinary research in modern biology, physics, economics, and computer science initiated a renewed interest in complex systems (Waldrop, 1992). From the outset, complexity science has relied on a process of gaining knowledge from shared ideas, methods, and experiences from diverse disciplines to understand the irreducible complexity of reality as a composite whole. Simon's approach on bounded rationality and his investigation of computers and artificial intelligence has been one of the most influential in developing complexity science. Information processing view on human cognition and decision-making (Newell and Simon, 1972; Simon, 1996) has provided crucial insights not only on decision science, but on complexity science. More recent applications of complexity to social science can be found in understanding cooperation (Axelrod, 1984, 1997), harnessing complexity for organizations (Axelrod and Cohen, 2000), enhancing policy analysis (Dennard, Richardson, and Morcol, 2008), improving business strategies (North and Macal, 2007), managing collaboration processes (Johnston, et al., 2008), and monitoring fraud in public programs (Kim, 2006).

Computer or computational modeling has been used as a key instrument in gaining knowledge on complex systems. These models aim to search for underlying mechanisms or understanding processes of dynamic open systems that present emergence. Policy Informatics also leverages the progress of complexity sciences. In study, complexity science provides guidance in grounding how to properly operationalize complex systems and 'wicked' problems in society and how to recognize patterns and mechanisms. Policy Informatics recognizes that policy making is a small but significant action in a much larger complex societal system. In service of policy decisions, policy informatics provides foundations for engaging various stakeholders in understanding complex systems and problems.

Exploring Meaningful Junctions between Governance and Policy Informatics

In addition to the more directly related fields of study discussed above, there is a close link between policy informatics and governance. In many respects, governance is the regulator that

shapes and controls the flow of policy decision making. And, as a result, governance has a very strong relationship with the use, availability, and even confidence in policy information. Unlike other fields, governance has been mainly descriptive. Below we further explore the relationship between policy informatics and governance through a historical review of the evolution of governance models. We also explore how current limitations in examining and articulating governance models can be informed by policy informatics.

Evolution of Governance

The governing structure that public administration scholars deal with is no longer limited to hierarchies. Relatively new types of governance structures such as networks and heterarchies of/in physical and virtual organizations have been observed in research and practice (Agranoff, 2007; Amin and Hausner, 1997; Malone, 2004; Provan and Milward, 2001). Complex adaptive enterprises are an emerging theme to conceptualize self-organizing natural, human, and social systems (Holland, 1998; Desai, 2005) and its relevance for governance has been explored in recent literatures (Axelrod and Cohen, 2000; Haeckel, 1999; Kernick, 2004; Kiel, 1994). These shifts draw attention to the perspective that we can make sense of the nature and appearance of these governance structures and provide relevant and timely advice for policy researchers and practitioners.

This use of language, governance, implies not only the enlargement of the scope and boundary of public administration and management, but also a different conceptualization of the work (Rhodes, 1996; Stocker, 1998; Boyte, 2005). Governance recognizes a complex set of institutions and actors beyond government, the blurring of boundaries and responsibilities for addressing social and economic issues, power dependence, autonomous self-governing networks of actors, and sees government as able to use new tools and techniques to steer and guide (Stocker, 1998). Therefore, it is more appropriate to see that the emergence of the governance concept redefines a focus on government as a single stand alone institution to a process that addresses complex, messy, and challenging problems (Rhodes, 1997; Hajer and Wagenaar, 2003). This broadened view has been more explicit with terms for a new form of governance such as network and collaboration.

Governance through network has attracted substantial scholarly attentions (Rhodes, 1996; Bueren, Klijn, and Koppenjan, 2003; Provan and Kenis, 2007). They argue that besides hierarchy, network consisting of nodes (social organizations) and relations can be equally effective in forming policies (Rhodes, 1996; Hudson, Lowe, Oscroft, and Snell, 2007) and in achieving goals (Provan and Kenis, 2007; Lubell and Fulton, 2007). Also, collaborative governance has emerged as a response to continuous social changes and complex social and economic problems (O'Leary, Gerard, Bingham, 2006; McGuire, 2006). This mode of governance brings multiple stakeholders together in common forums with public agencies to engage in consensus-oriented decision making (Ansell and Gash, 2007). Some have drawn distinctions between different modes of governance (Lowndes and Skelcher, 2002; Treib, Bahr, Folkner, 2007). We summarized our understanding on the evolution of governance in Table 1.

Table 1: Evolution in the Conceptualization of Governance

	Traditional	**Network**	**Collaborative**
Steering modes	Hierarchical top-down; legal sanctions	Non-hierarchical bargaining; positive incentive	Contingent; persuasion; learning and arguing
Assumption on actors	Homogeneous	Homogeneous	Heterogeneous
Actor choice	Dependent	Interdependent	Interdependent
Interest of the parties	Same	Same; Similar	Not necessarily the same
Stands on policy	Implementation of policy	Partnership for policy	Participatory policy-making; Co-production of policy
Levels	Within organizations	Between organizations	Across organizations
The role of IT	Improving efficiency	Improving communication	Facilitating conversations and debates

Limits of Current Approaches

The review of theoretical foundations shows that current research subjects are perceived much more complex and dynamic than early literatures have conceived. This evolution in

understanding the nature of reality highlights limits of traditional approaches that were useful in understanding static and constant problems within closed systems. Nevertheless, the growing literature on governance has urged mainly to better understand these changes and emphasized the potential utility of new modes of governance. Many discussions in the literature remain at the descriptive level or serve as a normative statement. In other words, new modes of governance have gained scholarly attentions, but processes and outcomes of the new modes have not been clear yet. We view the gap between how reality is and current methods available in the field as a major impediment for further progress.

Statistical modeling, for example, for a long time has been one of most popular approaches to understanding phenomena in public administration, management, and policy. Statistical modeling has been effective in identifying measurable factors that exhibit regular patterns in larger populations using small samples and distributional assumptions. In this approach, inferences to larger populations and estimating parameters have produced useful information, but many of the underlying processes that give rise to observable patterns are unknown. Further, statistical modeling has fundamental limitations in addressing scales and complex interactions and thus in revealing the nature of dynamic open systems. Despite of their success, therefore, statistical modeling provides limited ability to informing actions to complex phenomena or complex systems.

Now we find that we have choices on what is the most useful tool to inform policy-making. Advances in information and technology have allowed us to collect, store, and monitor large data stream real time with ever decreasing limitations. We became more worried about information overloads than shortages. Policy-makers are requested to evaluate the constant flux of data, interpret information, and generate evidence for crucial judgments. Questions on validity, legitimacy, and moral authority of their judgment are ever demanding.

Alternative Approaches

Since we claim that the current status of several fields are challenging beyond traditional questions, here we will explore new tools and techniques that presents potentials to explore such questions and how policy informatics can bring insights to fill the gap between the evolution of

governance and the current accepted response. While other methods, including network analysis, immersive visualizations, virtual reality, virtual worlds, and data mining are all relevant techniques for the policy informatics toolbox, we focus our discussion on the use of computer-based modeling to explore their value as research and decision support tools. As we mentioned, policy informatics studies the use of these emerging tools in the context of policy making. Their utilities and limitations are our particular interest to enhance methodology in the field and to properly inform theory and practice.

In the realm of research, modeling is a way of understanding the world. A model is like a map of certain systems or structure. Simulation is a particular type of modeling for various purposes such as prediction and understanding. Early computer simulation in social science can be found from discrete event simulation and system dynamics that model queues, processes, and the trajectories of variables over time. The development of simulations in social science is well discussed elsewhere (Gilbert and Troitzsch, 2005; Marcy and Willer, 2002). In more recent years, scholars have been interested in some issues that are specific to the social sciences and the relevance of computer simulation to understanding human societies. With the development of complexity sciences, for example, agent-based modeling has been adopted as an increasingly common modeling technique.

Agent-based models are different from classical simulation models in that heterogeneous agents directly interact with each other and adopt their behavior based on local information available. Agents can be representative of any objects from humans to concepts. Action rules specify how agents interact. This approach has been used for many purposes, such as modeling emergence (Holland, 1998), far-from equilibrium behaviors (Bak, 1991, 1996), constructivist learning and challenging assumptions (Resnick, 1994), virtual laboratories (Casti, 1997), technological or engineering applications (various applications based on object-oriented programming), and urban planning (Guzy et al., 2008).

One famous example of how agent-based models were used for theory development is Axelrod's (1984, 1997) work that studied under what conditions cooperation will emerge when egoists compete in a game without central authority. The study showed that the norm of reciprocity made it possible for cooperation to emerge (Axelrod, 1984). Cooperation emerges because of the

possibility that the players will meet again even when the assumption of self-interested rational agents is not abandoned. In a later study on the emergence of norms as solutions to dilemma of collective action, Axelrod (1997) chose to implement an evolutionary approach. The initial strategies are chosen at random, and strategies also undergo some random mutation. Agents no longer need to be rational. Players are given the opportunity to defect and to punish the defections they observe. The study identified a 'metanorm' (the treatment of non-punishment as if it were another form of defection) as a mechanism that could sustain a partially established norm. This example shows a unique capability of agent-based models in building or extending theory.

While the former focuses on understanding the underlying processes of social phenomena, there are also examples of artificial worlds used to understand how complex problems emerge. Scientific, repeatable, and controllable tests on human subjects are not easy due to ethical, theoretical, and practical issues (Nan and Johnston, 2008). Artificial worlds can be a laboratory for testing policy interventions. Chris Barrett at Los Alamos built TRANSIMS in order to tackle Christmas-shopping congestion on Louisiana Boulevard in Albuquerque, New Mexico (Casti, 1997, pp. 131-142). The main questions in the simulation were how a proposed change in the system creates traffic patterns and how these patterns impact the environment. The motivation for this approach is that by creating the phenomenon of interest from the interaction of heterogeneous agents and simple rules, one develops an understanding about how the phenomenon came about (Epstein & Axtell, 1996). Once understood, the potential for successful intervention, as is necessary in policy problems, increases. The structure of the TRANSIMS consists of massive data and information from travel demand and transport system data, trip route plan generation, traffic micro-simulation, and environmental simulation.

Policy Informatics leverages and informs the progress of governance discussion both through study and service. In study, the recent development of governance debates provides guidance in grounding how to understand conflicting values of heterogeneous actors and focuses on the *process* of coordinating individual actions within larger contexts (Johnston et. al. 2008). Policy Informatics recognizes that policy making is a communicative activity constrained by various groups with overlapped but conflicting goals. In service of policy decisions, policy informatics provides technical foundations for extending the debates and examining the process.

Research Agenda in Policy Informatics

Policy informatics, at its core, tries to understand complex human actions for effective societal development. By stating the core of policy informatics as such, we are immediately confronting several challenging questions: how to make sense of, coordinate, inform, and evaluate autonomous human actions in interconnected worlds? Ultimately, how can we flexibly manage continuously changing environments without losing accountability and ethical standards? Abstractions and concepts can be relied on only if they are constantly checked against concrete results. How to constantly check the abstractions we are building against a continuously updated and revised reality so as to thoughtfully inform policies in changing worlds? While the number and variety of research questions in policy informatics are limitless, we came up with three general research questions that are particularly relevant to the study of policy informatics.

First, *how do we develop and validate meaningful or useful models of complex systems?* A common critique is that simplifying the model of complex reality into reduced forms significantly decreases the credibility and applicability of the findings especially in the context of complex policy making. On the contrary, complex models reduce intuitive appeal and understanding for the audience, thus raise the validation questions of grounding, calibration, and verification. One way that we can balance these challenges can be to create a deliberate plan for validation at the onset of the modeling project and continual interaction between scientists and stakeholders. However, how to implement this idea is widely open to researchers, dependent on research objectives, and tempered by the scope of the claims.

Second, *how can we bridge the gap between the new sources of knowledge generation we have proposed and the policy makers, including non-technical experts and everyday citizens?* One of the end goals of policy informatics is to inform decision makers and thus the tools used are in service of a larger policy making process. One way we have identified to bridge this gap is to include decision makers in the model building process itself (Johnston, Kim, & Ayyangar, 2007). However, when not possible, a large immersive visualization environment (such as the Decision Theater at Arizona State University) can provide an appropriate forum to bring people together, see the shared context, and engage in informed conversations. A challenge with this, as with any

other type of model, is to remain politically neutral at least in its process. If stakeholders think the model and thus the process is inauthentic, then they will be less likely to engage in sincere discussion or be satisfied by the conclusions reacted through deliberation (Cash, et al., 2003). Therefore, information choice, use, and effectiveness in policy decisions are deserving of greater scrutiny in efforts to inform policy making. As policy makers we must makes models as transparent as possible to avoid the threats to modeling fidelity including: wrapping in solutions when convenient, ignoring qualitative elements in favor of the quantitative ones, and making claims on a scale not supported by the validation plan.

Finally, *how do we evaluate the usefulness of these efforts in general and specifically in relation to traditional policy approaches?* This question opens a new area for evaluation community. Since we propose to change the way that we do science, the evaluation criteria of such activities need to be reconsidered. For example, we need to discuss which traditional evaluation criteria are still relevant for evaluating actions in changing worlds informed by these very different tools and approaches and how traditional evaluation criteria can continue to add value in new approaches. We need to answer why and how certain tools and techniques work in policy-making settings. Under what conditions such tools are more effective and informative. What barriers prevent actions of policy makers even if reasonable advices were provided and why? How to feed the findings of practices back to the theory?

Discussion

The progress in the field of policy science has been continuously made since Lasswell put the area in the direction of "the policy science of democracy" (1951, p. 5), emphasizing contextuality, problem-oriented, and a synthesis of techniques (1970). Policy informatics ultimately aims to improve public policy and decision-making at federal, state, local, and community levels. While traditional analytical techniques and tools have been useful for knowledge building, there have also been several limitations in addressing or incorporating complexity of public policy. We still need to go a long way in order to create truly interactive analytical tools to inform policy debates.

The field of policy informatics is aggressively evolving through synthesizing and mixing

different analytical tools and techniques to come up with novel and innovative approaches. Our imminent policy issues in communities and locals provide a fertile context for those trials. While we need to pursue the path that minimizes errors, we need stepping stones to build the road. But we move forward with a purpose. Our future research plan is to build evidence on successful trials in this direction and to advance the area of policy informatics. Finally, it seems that it is useful to close this paper by quoting insights of two of the leading scholars in Public Administration:

> *Patterns of interdependencies in modern societies become extraordinarily complex and reach out to global proportions. Yet economists, other social scientists, and social professionals in there efforts to explain social reality reply upon extraordinarily simplified concepts that increasingly distance themselves from social reality. Eucken argued that we as social scientist face the problem of developing analytical tools to penetrate social reality rather than distancing ourselves form it. Eucken did not resolve the challenge he presented; it remains a challenge for all of us who are concerned with the study of human societies. Eucken's challenge, like the conceptualization of what is public, will always confront scholars in the social sciences, humanities, and social professions. (Ostrom, 1989, p. xvi)*

> *The question for research agendas in the 1990s is, Are current research approaches sufficiently subtle and complex to sense and make sensible the subtleties and complexities of organized social action in an increasingly interdependent and turbulent global environment? The answer seems obvious. No one pattern of subtlety and complexity is anywhere near sufficient. The only way we can generate the requisite complexity to grasp the complexity that surrounds us is to become an inquiring community in which there is respectful complementarity, integration, listening to one another, an ethic of mutual helpfulness, and nonstop conversation (Weick, 1992, pp. 177-178)*

We believe the field of public administration has been focused on examining or exploring the next advance in information management without taking the time to build a framework for systematically investigating underlying patterns of complex and sometimes subtle policy decision-making behavior. In some respects, it has been too easy to get caught up in the excitement of e-government, the Internet, and digital solutions without taking a closer look at how these systems are changing the way policy decisions are being made. The emerging field of policy informatics is a chance to build a framework that learns from several existing fields of study (behavioral economics, decision support systems, complexity theory) while at the same time incorporating the concepts of governance, public service, and democratic institutions.

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