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A fresh look at a policy sciences methodology: collaborative modeling for more effective policy

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A fresh look at a policy sciences methodology: collaborative modeling for more effective policy

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ABSTRACT

Collaborative modeling offers a novel methodology that integrates core ideals in the policy sciences. The principles behind collaborative modeling enable policy researchers and decision makers to address interdisciplinarity, complex systems, and public input in the policy process. This approach ideally utilizes system dynamics to enable a multidisciplinary group to explore the relationships in a complex system. We propose that there is a spectrum of possibilities for applying collaborative modeling in the policy arena, ranging from the purely academic through full collaboration among subject matter experts, the general public, and decision makers. Likewise, there is a spectrum of options for invoking collaboration within the policy process. Results from our experiences suggest that participants in a collaborative modeling project develop a deeper level of understanding about the complexity in the policy issue being addressed; increase their agreement about root problems; and gain an appreciation for the uncertainty inherent in data and methods in studying complex systems. We conclude that these attributes of collaborative modeling make it an attractive option for improving the decision-making process as well as on-the-ground decisions.

INTRODUCTION

Since inception, the policy sciences have invited scholars and practitioners to seek innovative ways to improve the policy process and policy decisions. This has often included revisiting concepts and tools to see whether they might be applied in new ways. The ideas expressed in this article combine existing tools and concepts synergistically so as to generate novel ways to approach policy development. We propose employing system dynamics-based collaborative modeling as a method to revitalize several core ideals in the policy sciences. Specifically, the principles behind collaborative modeling enable policy practitioners to

– Integrate scientific information, local knowledge, and values into the policy process;

– Facilitate an interdisciplinary understanding of the system under study;

– Facilitate problem identification to reach agreement on the root problem;

– Enable improved ‘‘on-the-ground’’ decisions.

The rich history of the policy sciences includes interdisciplinary, contextual roots with branches in rational positivist approaches, which have recently taken a turn as practitioners and theorists revisit the field’s origins. In his seminal piece on the policy sciences, Lasswell (1951) built on Charles Merriam’s work, which emphasized ‘‘breaking down barriers that separate scholars from one another, and of leveling-up methodological competence everywhere.’’ Early policy sciences practitioners were ‘‘intellectual border-crossers’’ (Chetkovich and Kirp 2001), and their vision was for policy to combine diverse disciplines in a quest to find better responses to policy issues with a strongly democratic focus. Lasswell (1951) recognized that context is key and that our most powerful and creative results arise when we ‘‘unify quantitative and nonquantitative observations and point the way to new empirical, theoretical, and policy activities.’’ Policy sciences originated at a time when science and technology were perceived as positive social forces, and there was emphasis on applying the success from physical science to better understand human behavior. Although Rothwell (1951) says that the idea of science as savior was waning, early discussions in the policy sciences reflect an emphasis on physical sciences (physics envy) as a strong influence, and ideas about rationality and objectivity seem to reflect a reductive approach. In fact, contemporary scholars have reviewed Lasswell’s work for its positivist or post-positivist traits (Torgerson 1985; Pielke 2004; Thomas 2006).

By the late twentieth century, there is no doubt that the rational model for policy making (as well as for scientific endeavors) was being actively debated (Lindblom 1979; Healy 1986; deLeon 1994; Stone 2002). Weiss (1991) wrote of social scientists, ‘‘If they no longer claim to find ‘truth’ about ‘reality’, what is their role in the policy process? The time seems to have arrived for a new set of assumptions and arrangements.’’ In response, emphasis was placed on recognizing interconnected systems and employing a holistic perspective rather than a reductionist approach, especially for linking social and ecological systems (Gunderson et al. 1995; Berkes et al. 1998). There have been calls to make complexity itself a focused topic within policy sciences (Hendrick and Nachmias 1992). As social issues were recognized as complex and intractable, interdisciplinarity again came to the fore as a preferred approach to try to address the complexity (Klein 1990).

Coinciding with this re-turn to interdisciplinary, contextualized policy sciences were demands for public participation in policy-making. Ideas about public participation evolved from calls to simply be told what is happening, to the idea that sound policy requires collaboration among the public, technical experts, and decision makers (Langton 1978; Selin et al. 2000; Wondolleck and Yaffee 2000; Connick and Innes 2003). This raises the interdisciplinary origins of policy sciences to a new level, with the public providing another layer of 'disciplines' while at the same time embracing the complexity in social systems.

Overlying this attention to interdisciplinarity, complex systems, and collaboration were tremendous advances in computers and computer-based modeling. We suggest that this history has created an opportune time for the policy sciences to revisit Lasswell's (1951) ideas about models, both cognitive and mathematical. He wrote, ''When one thinks in basic policy terms, it is essential to operate with models whose elaboration is sufficient to enable the investigator to deal with complex institutional situations.''

The use of mental models has always been part of the policy sciences and using computers is also not a new idea. In fact, the first issue of Policy Sciences included an article on using a ''teaching computer'' to involve the public in policy decision making (Umpleby 1970). Computers enable us to capture and store vast amounts of information in tremendous detail, and we gather information faster than we put it to use (Esty and Rushing 2007). Our data-rich culture offers promise for using computer-based models in policy making. To be clear, computers (or any technology) do not automatically contribute to improved policy, but as we shall discuss, a collaborative modeling approach does show potential for deeply integrating policy sciences ideals into the policy process.

Our intent is to (re)-introduce concepts inherent in collaborative modeling to contemporary policy sciences. This is a relatively new and rapidly evolving methodology that does not currently offer significant empirical evidence. In addition, collaborative modeling well fits post-positivist ideas that complex social issues are resistant to empirical review. As Mingers and Rosenhead (2004) note in discussing problem-structuring methods (PSM), real world situations using these approaches are unique and not often replicable. Therefore, ''laboratory'' style assessments are not necessarily productive. In addition, in reviewing public participation in the environmental arena, Dietz and Stern (2008) note that there are no ''best practices'' for all contexts because public participation is situation dependent. The case studies cited here do, however, offer tremendous insight and 'lessons learned' into the collaborative modeling methodology. The growing number of cases being reported suggests at least two things. One, policy sciences practitioners continue to seek better methods and two, participants perceive collaborative modeling to be a positive and promising approach. Exploring the potential for this approach has value for the policy sciences and is the focus of this article.

COLLABORATIVE MODELING

The literature reveals case studies employing the terms mediated modeling, group modeling, participatory modeling, shared vision modeling, companion modeling, and cooperative or collaborative modeling. This is an excellent example of ‘‘convergent evolution’’ in methods, as these ideas have come to the fore roughly simultaneously but have been uniquely labeled. Some authors are beginning to document distinctions among the various labels. For example, Renger et al. (2008) suggest that group modeling involves working directly with a client, mediated modeling is largely applied in complex ecological problems, companion modeling utilizes role playing games, and participatory modeling is used to cross different approaches. Various team-based modeling approaches fit well with PSM and Andersen et al. (2007) note that group modeling can integrate the ‘‘soft’’ and ‘‘hard’’ elements of PSM. Vennix (1996) well defines group modeling and discusses when and how to engage a team. Rouwette et al. (2002) provide a review of more than 100 examples of using group modeling in organizational settings. In addition, there are numerous case studies documenting collaborative modeling efforts in natural resource management (Cockerill et al. 2007; van den Belt 2004; Nicolson et al. 2002; Eeten et al. 2002; Costanza and Ruth 1998; Moxey and White 1998; Palmer et al. 1993).

We use the terms collaborative or cooperative modeling interchangeably to mean any method that brings together a multidisciplinary group and employs a ‘model’ to better understand key relationships in the system being studied. Models can range from simple diagrams of causal behavior to complicated computer-based simulations. If the team deems it prudent, they construct a computer model to enable them to play ‘what if’ games to massage the system to see what happens if various policy options are implemented.

In the case studies documented, modeling teams vary greatly in size and composition, including disciplinary expertise and functional roles (e.g., professional researchers, members of the public). Applicable to policy sciences, key elements in collaborative modeling are to ensure, to the extent possible, that geographic and subject matter interests are represented and that teams do cross disciplinary boundaries, including using local knowledge. Collaborative modeling offers similar advantages to joint fact finding, including granting primacy to stakeholders in defining the issues, jointly interpreting scientific (and other) information, and jointly recognizing the limits to available information (Susskind et al. 2007). At least one team member does need to be well versed in scientific modeling, whether to formulate qualitative conceptual tools or to write the necessary code if a computer model is designed. Many teams employ a facilitator and/or a note taker. The process for collaborative modeling is flexible to allow a team to meet the needs of their specific project. Some projects may be completed in a single meeting while others are multi-year endeavors. Traditionally, the team will meet face to face, but technology now makes it possible to conduct ‘virtual’ meetings that allow even geographically dispersed teams to work collaboratively.

SYSTEM DYNAMICS

Collaborative modeling is not a technocratic approach to policy. The collaborative modeling framework needs to be selected such that both the technical and lay stakeholders are equally comfortable with the tools and the process. System dynamics has a rich history in this context. Its attractiveness stems from the fact that much of the actual ‘modeling’ does not involve the computer. Key to the system dynamics approach is the value of eliciting mental models from participants and capturing local knowledge about the system (Forrester 1992; Vennix 1999). A ‘textbook’ attempt to model a problem using the system dynamics approach starts with listing variables of interest, creating reference modes or time graphs, building causal loop diagrams to show the relationships among variables, developing dynamic hypotheses and then, if required, building a computer model (Sterman 2000, emphasis added). In fact, the authors have participated in collaborative modeling projects where the computer model itself became secondary to the process of verbalizing and diagramming the relationships in the system being studied. While the non-computer features of collaborative modeling are important, Forrester (2007), the ‘founding father’ of system dynamics states that, ‘‘Only by going the full road to extensive computer simulations is one prepared for the depth of understanding required in real world situations.’’ This is in part because humans are not terribly efficient at processing nonlinear relationships or feedback loops, and the computer expands our ability to see complex relationships (Vennix 1999; Forrester 2007).

While the idea of collaborative modeling is relatively new, system dynamics has a long history in both business and policy arenas. Journal articles from the 1970s discuss the benefits and pitfalls of the dynamic model (Averch and Levine 1971; Jantsch 1972; Forrester et al. 1974). Perhaps the most well-known use of system dynamics was in the report, Limits to Growth, which used the World Model (Meadows et al. 1972). Numerous trees have been felled to allow scholars to contemplate the relative success (or lack thereof) of this model. Unfortunately, the ideas in Limits to Growth were interpreted as robust predictions and were characterized as doomsday scenarios with insufficient quantitative evidence (Gillette 1972; Yenson 1973; Koehler 1973). Interestingly Limits to Growth authors repeatedly state that they were not making predictions, but were showing trends that could prevail if existing practices continued. In hindsight, the criticism is not surprising as it does reflect reductionist attitudes about what policy sciences should do (i.e., predict) as well as a reluctance to talk about limits and address difficult realities. In addition, the computer capabilities at the time were not ‘user-friendly’ and were not accessible to the average person. Probably due to the strong critiques, this early attention to system dynamics dissipated within the policy sciences.

APPLYING COLLABORATIVE MODELING IN POLICY

Building on ideas from Hendrick and Nachmias (1992) and Stewart and Ayres (2001) about systems thinking and its application to policy, we propose that policy may be well served by revisiting system dynamics modeling as a collaborative tool. Figure 1 shows a spectrum of possibilities for a collaborative modeling process and a separate spectrum for using output from collaborative modeling in the policy arena. It is important to distinguish between the model development process and a policy-decision process. For some issues, it may be advantageous to have a fully collaborative model development process that then enables a more restricted, potentially more efficient decision-making process. In other circumstances, there may be limited collaboration in model development and therefore it may be useful to engage in a more collaborative decision-making process. For many cases, the complexity and contentiousness may require strong collaboration in both the modeling effort and the actual decision-making process.

The simplest form (in relative terms) of collaborative modeling is the academic approach. These types of projects do not involve decision makers or the public. In this approach, a multidisciplinary group of experts collaborates to generate an interdisciplinary perspective of a specific system and to develop a model to reveal key relationships in that system. The authors have participated in several projects of this type, including one to better understand migration (legal and illegal) across the US–Mexico border (Malczynski et al. 2005) and one to assess land use change related to water availability (McNamara et al. 2004). Moxey and White (1998) document an academic interdisciplinary modeling project for river catchment management. In these projects, teams learned lessons in crossing disciplinary boundaries, applying data using diverse methods, and integrating data and information into a computer model.

As many readers might have hypothesized, output from these academic projects has not been integrated into actual policy decisions. One explanation for the lack of attention is ignorance. If policy makers do not know that a model development process has happened or that a model exists, they cannot apply insight from the process or products. Even with a ‘marketing strategy’ that informs policy makers about a model, they may not embrace it. There may be competing models available and policy makers may be wary of ‘dueling models’ especially if they are familiar with another model that provides different results. King and Kraemer (1992) note that models have often been political tools used in partisan debates. Decision makers are especially unlikely to accept a model ‘cold’ if the results violate their preconceived notions about the system under study or if the results are politically unpalatable. Forrester (1992) has written that it took about five hours to explain why his Urban Dynamics model generated the results it did. Although some of the trends that his model showed became the reality for urban settings, his model was heavily criticized because the results violated prevailing social ideas and norms. Our experience with border migration modeling echoes this. Policy makers are reluctant to accept the results because they do not comport with existing policies. As Stave (2003) reports, a decision-maker may want just enough information to address the problem, but not be interested in actually understanding the underlying system or in challenging commonly held basic beliefs. Models (or other information from a model development process) that do challenge these beliefs are likely to be disregarded. Moxey and White (1998) suggest that their model became ‘‘shelfware’’ for a variety of reasons, including suspicions about data sources and model structure as well as concerns that the model would replace professional judgments in management decisions.

While academic efforts provide valuable lessons to participants and do contribute to further developing the interdisciplinary and technical goals of the collaborative modeling method, they are limited in their benefits to the policy process. From a policy perspective, a key value of the system dynamics model development is to enable structured dialogue among stakeholders, to integrate local knowledge with scientific principles, to express competing interests and to directly engage those who will eventually make policy decisions. This cannot be achieved in a purely academic setting. In fact, Forrester (2007) posits that the trend toward pulling system dynamics into academia and away from actual policy processes has been a failing of the system dynamics community.

Next in the spectrum of collaborative modeling possibilities is a minimalist level, in which a modeler (and perhaps a few subject matter experts) collaborates with a decisionmaker to explicate a particular system. This is reminiscent of professionalized notions of policy analysts who provide data and information to a decision maker who then makes a top-down decision. This 'chauffeuring' approach has roots in the information systems community early in the computer era when computers were more difficult to use. By working directly with the decision maker, there may be greater potential for research-based information to combine with value-based politics to ''speak truth to power'' (Wildavsky 1979).

Because the chauffeured process does not include stakeholders, a barrier to its application is ensuring public 'buy-in' to the model. If interest groups or members of the public do not trust the policy maker, or if people do not trust the modeler or subject matter experts, they will not likely trust the model. Cockerill et al. (2004) showed that although the public supported using models in making policy decisions, respondents reported that it did matter to them who built and who used the model. Yearley (1999) also found that who used a model affected public attitudes about the appropriateness of employing models in the policy process. If there is trust among the stakeholders and the decision makers, however, it is possible to walk the stakeholders through the model development process and provide an opportunity for them to play the 'what if' games, which may help overcome initial concerns.

A potentially more insurmountable barrier lies in the contemporary emphasis on collaboratively developed policy. Many policy makers are wary of pursuing anything that might be perceived as a 'closed door' approach. Therefore, even in a high trust situation, having a decision maker work directly with a modeler may be politically unpopular. In addition, walking through a system dynamics modeling approach is time intensive and hence many decision makers may be unwilling to invest that time. Yet, as Leeuwen and Breur (2001) describe, a modeler and a policy maker working closely together, compared to a modeler working alone, can contribute to a more useful product that is politically defensible. We believe that directly applying system dynamics ideas into the policy arena in this way is quite promising, but have not had the opportunity to explore it more fully with a 'real world' project.

Our collaborative modeling experience includes projects at the fully collaborative end of the spectrum in Fig. 1. Two projects illustrate the barriers in collaborative modeling as well as the ways this approach can positively contribute to the policy sciences. First, from 2002 to 2004, a regional water planning effort in New Mexico employed a publicly driven collaborative modeling project. Participants reported that the process of building the model clarified issues, made the connections among variables apparent and enabled the planning team to develop a plan (Tidwell et al. 2004; Cockerill et al. 2006). The model suggested that fairly draconian measures would be required to balance water supply with predicted water demand. For the modeling team and individuals at public meetings, the model provided a ''wake-up call'' as to the seriousness of the water situation (Cockerill et al. 2004). No decision makers participated in the collaborative process, and some did not 'like' the model's results and hence were critical of it.

In the second example, between 2005 and 2007, a multidisciplinary team that included subject matter experts, members of the public, and decision makers developed a model that will be the one tool among several to help make a water-resource management decision in southwestern New Mexico. Participants reported that the process provided a necessary opportunity to identify key relationships, to utilize local knowledge, and to elicit values that are crucial to the ultimate policy decision. A couple of participants expressed concern that specific interest groups wielded too much influence on the modeling project and will have too much influence in the eventual policy decision. Overall, however, participants agreed that the process was better off with the collaboratively developed model than without it.

Comparison between these two projects highlights the importance of having decision maker's attention in collaborative modeling. If the model development team has a positive relationship with decision makers, then reporting unpopular results from the process and the model is easier. As they participate in identifying variables, relationships among variables, and data sources, team members (including the decision makers) are less likely to question model results and more likely to integrate insight from the process and the model into the decision-making process. This is not to suggest that these more inclusive teams are problem free. There is pressure on decision makers to ensure that the process remains politically viable and hence they can potentially limit the scope of exploration in a modeling process, and teams need to guard against this.

In both cases the benefits of collaborative modeling were numerous. Participants identified data sources that would not have been readily available to the modelers through traditional channels (e.g., published reports, public databases). They also provided local knowledge relevant to the system being modeled. Team interaction, while sometimes contentious, was instrumental in identifying what was important to the participants and in clearly defining the problem as well as the complexities surrounding the problem. As Stone (2002) sees it, this clarification of what is important gets at the heart of policymaking. In addition, Dutton and Kraemer (1985) suggest that models can help in getting to the problem because participants can direct their concern, anger, and/or distrust toward the tool (or the data being used in the tool) rather than at each other, and this may enable a more stable and positive group dynamic.

POLICY IMPLICATIONS

As Mingers and Rosenhead (2004) note about PSM, our collaborative modeling efforts have been largely pragmatic. We developed approaches and applied them, and then looked to the literature and found that others had shared experiences and were beginning to develop the theoretical underpinnings. Based on our body of work and the subsequent literature reviews, we conclude that applying collaborative modeling in a policy process can contribute to diverse goals, including integrating values and various types of information; promoting an interdisciplinary approach; focusing on problem identification; and improving actual decisions.

Integrating scientific information, local knowledge, and values into the policy process

There are dual pressures in the policy process to utilize the best available science while integrating public input. Unfortunately, these are not always able to be implemented simultaneously. For many issues there is significant scientific disagreement; there is high variability among the ways the public and scientists interpret events, observations and data; and there are competing ideas and concerns from the public. In collaborative modeling information and data may come from traditional scientific sources or from team members intimately familiar with the system. Employing collaborative modeling, may help realize Wildavsky's (1979) idea to combine the power of intellect (identifying what we do know), with the power of social interaction, which is at the base of politics and policy. Collaborative modeling makes real Lasswell's (1951) idea that ''policy sciences are advanced whenever methods are sharpened by which authentic information and responsible interpretations can be integrated with judgment.''

Collaborative modeling may also contribute to Hoppe's (1999) idea that, '''speaking truth to power' may be transformed into an argumentative policy analysis which reinvigorates political prudence as 'making sense together.''' As Poncelet (2001) concludes, collaborative efforts can promote ''personal transformation'' and this can contribute to seeing problems and possible solutions in a new way. Using a collaborative modeling approach can offset the 'squeaky wheel' that allows whoever raises their idea most loudly to push a group toward consensus. The collaborative modeling approach, which integrates numerous and diverse data can allow a group to see that the 'squeaky wheel's' option may not be the best (Poncelet 2001). As King and Kraemer (1992) suggest, models may be most effective at showing what not to do.

This approach can reduce Lindblom's (1990) ideas of impairment by utilizing lay knowledge and encouraging engagement among disciplines to reveal a more holistic view of a particular system. In particular, collaborative modeling utilizes system dynamics because this method allows 'mental models' to be encoded into the computer model, which enables users to explore relationships even where numeric data are weak (Sterman 2000).

One benefit of this approach is to alleviate fears of technocracy and the idea that decision makers are abdicating responsibility to a computer model (Saunders-Newton and Scott 2001; Moxey and White 1998). Because stakeholders are involved in creating the model, the process, the data, and the end product are not a 'black box' that generates a solution. To the contrary, a collaborative modeling team establishes a common knowledge base to help participants (including decision makers) better understand complexity, to ask better questions, to engage in dialogue, and to negotiate the possibilities for developing policy.

Generate an interdisciplinary understanding of the system under study

Interdisciplinarity and systems are fundamentally linked. As a tool for promoting interdisciplinary work, a collaborative modeling process can help with the integrative process (Newell et al. 2005). Because most policy issues involve complex systems, collaborative modeling must include people fromdiverse disciplines/backgrounds to ensure that all relevant ideas are integrated into the process and the model. A key component of system dynamics work is developing the causal loop diagrams to show how variables relate to each other. This requires establishing common language and utilizing methods and data sources across disciplines. The literature suggests and our experience supports, that through the process of identifying the relationships and seeing how variables interact, the team moves toward interdisciplinary thinking and develops a common understanding of the issue (Palmer et al. 1993; Vennix 1996; Rouwette et al. 2002; Eeten et al. 2002; van den Belt 2004; Cockerill et al. 2007). As stakeholders engage in collaborative learning, they ‘‘overcome barriers and link theoretical knowledge to practical knowledge’’ (Randolph and Bauer 1999). In this way, participants develop a larger perspective beyond their area of knowledge or expertise.

Facilitate problem identification to reach agreement on the root problem

Our experience suggests that system dynamics-based collaborative modeling is a positive tool to help elucidate the problem definition stage of the policy process. deLeon and Steelman (2001) conclude that contemporary policy education (and hence practice) emphasizes finding a solution without fully understanding the problem. Case studies of collaborative modeling for a variety of subjects show that the technique increases knowledge levels and leads to increased agreement about what the root problem is (Costanza and Ruth 1998; Rouwette et al. 2002; van den Belt 2004; Cockerill et al. 2006). As Cates (1979) urged more than two decades ago, if we want better policy, we need better, more creative approaches, which includes asking different questions. That same year, Wildavsky (1979) also suggested that the key to better policy is in the question, not the solution. This is why the ‘what if’ component of a system dynamics model—in both the product and the process—may be what is most valuable to effective policy making. By continuously digging for potential connections and feedback loops, system dynamics helps collaborative modeling participants identify those key questions at the root of the issue.

Any collaborative team may have misperceptions about their level of consensus. As Leong et al. (2007) discuss, some teams think they agree when they really have fundamentally different views of what the problem is (false consensus) or they may believe that they fundamentally disagree, when in fact they do agree on the basic problem to be addressed (false conflict). The system dynamics approach can make these issues explicit as the team discusses causal relationships or as they exercise the model through a variety of ‘what if’ scenarios and argue their relative tradeoffs. Recognizing and addressing points of disagreement (real and perceived) can be crucial to identifying the root problem.

Improve ‘on-the-ground’ decisions

The impetus for the policy sciences was (and is) to improve the policy decision process as well as the actual policies implemented. Integrating various forms of knowledge with values, employing interdisciplinarity, and getting at the crux of a problem all contribute to making better ‘on-the-ground’ decisions. The benefit of collaborative modeling using system dynamics is that the sum of these is greater than the individual parts. The synergy created through the collaborative modeling approach can generate a new context in which policy decisions are made. This is its greatest potential for the policy sciences.

Unlike some early ideas about both policy sciences and computer models, we do not promote a rationalist idea that collaborative modeling will necessarily provide solutions to any issue. Rather, we have found that this method brings system complexity to the fore and highlights that there is no silver bullet for any policy issue; that specific, quantitative predictions are fraught with uncertainty; and that there are numerous possible approaches, each with its own tradeoffs. Increasing understanding and acceptance of complexity and uncertainty has potentially far reaching implications for policy development and implementation. For example, the requirement to accept uncertainty has often been a barrier to implementing adaptive management strategies. Perhaps in the long term, collaborative modeling approaches can help alleviate this barrier (van den Belt 2004; Riley et al. 2003).

The collaborative modeling approach forces attention on ideas like collaboration and consensus. Although it has become a buzzword within policy, there has not been significant analysis completed on if and how policy outcomes are improved through collaboration. Scholars have begun studying the effectiveness of the various approaches and there is evidence that collaboration does not necessarily contribute to better or more timely policy responses (Lubell 2004a, b; Weible et al. 2004; Hoppe 1999). In addition, consensus tends to be a driving goal in many public and/or collaborative processes and there is ongoing debate about the value of consensus in policy making (Kerkhof 2006; Coglianese and Allen 2003, 2004). Kellermanns et al. (2005) provide an overview of the conflicting results regarding strategic consensus and offer suggestions for resolving some of these conflicts. Hines and House (2001) developed a model showing that in group efforts there is a drift toward consensus even if the consensus ‘‘answer’’ is not the optimal answer. Kerkhof (2006) reported that participants in a deliberative process tended to strive for consensus and avoid conflict. This tendency has a long history in our political and social world, but it may not be the most productive for improving policy. There is some evidence that although it makes people uncomfortable, structured conflict can help achieve decision consensus (Dooley et al. 2000) and generate better ideas (Putnam 1986; Lindblom 1990; Kenney 2000). There is also evidence that in ‘‘wicked’’ or ‘‘messy’’ policy problems (those that seem to consistently generate conflict and may never be ‘solved’), models can help us use conflict productively (Vennix 1996; Nie 2003).

Pertinent to our work is the distinction between consensus as dialogue compared to consensus in decision making that Coglianese and Allen (2004) raise. There is value in trying to ‘get everyone on the same page’ and this is different than getting to a decision that everyone ‘can live with’, which is often the outcome of consensus-based efforts. Kenney (2000) draws a distinction as well between a process that generates a sense of community with a process that generates improved 'on-the-ground' decisions and research suggests that collaborative/consensus driven efforts often achieve the former, but not necessarily the latter. There tends to be tremendous faith placed on the idea that consensus (in the sense of unanimity) is truly achievable and that there are 'win–win' possibilities for every situation that will improve the end policy result (Kenney 2000; Hooper and Lant 2007). Collaborative modeling can reveal that there may not be a win–win option, especially in the long term, and that there are difficult choices that must be made. As Forrester (2007) points out, a profound contribution that system dynamics (and by extension, collaborative modeling) can make to policy sciences is to refute the idea that there are simple solutions to complex problems.

We argue that in conjunction with this deeper appreciation for the complex, uncertain nature of policy issues, collaborative modeling can perhaps enable a shift away from intense collaboration at every stage of the policy process. Our experience fits with ideas in perceived justice, which suggests that if the leaders are trusted and if people feel that they have been heard, then they perceive the process as fair and this can be more critical than perceptions of the final decision (Korsgaard et al. 1995). We believe that collaborative modeling best serves policy when it is engaged early in the policy process and is separate from the actual decision-making process. If the collaboration in the modeling component is sufficiently strong, then perhaps the actual decision-making phase can be more flexible in terms of whether it is decision-maker driven (top-down) or collaborative. By fully involving stakeholders and decision makers in model development, they achieve an interdisciplinary connection and come to share new mental models of system complexity. Then, even if the decision-maker develops policy in a less participatory way, the decision is based on a shared understanding of variables and their relationships. Employing collaboration in this exploratory fashion is potentially more effective than trying to develop actual policy in a collaborative setting.

In addition to helping generate improved policy, the collaborative modeling approach may also be well suited to document how a particular policy came to be and to show the effects from a specific policy decision, including the roles that collaboration and consensus may have played. Because the modeling process is intended to capture feedback loops and nonlinear relationships, it can capture the complex nature of the decision-making process and the consequences (including unintended ones). This seems to us to be an excellent avenue for academic collaborative modeling efforts.

CONCLUSION

There are interesting parallels between the ideals of modeling and the ideals of policy analysis. The oft quoted idea that, ''all models are wrong; some models are useful'' (Box 1979) is analogous to Lindblom's (1979) idea that all analysis is incomplete, but that analysis designed with that incompleteness in mind is better than analysis with random incompleteness. This is perhaps a fundamental benefit of the collaborative modeling approach in that it may help us reject the idea of a silver bullet, the perfect solution waiting to be discovered. As Rosenhead (2006) noted, ''Turbulence rather than stability has become the commonsense perspective on the future.'' The collaborative approach employing system dynamics may help subject matter experts, the public, and the decision makers to better accept ambiguity, uncertainty, and the reality that there is no simple or single solution in making difficult decisions. As Dutton and Kraemer (1985) recognized in the early years of computer modeling in policy work, ''The policy making process in the information society will remain highly political rather than becoming highly rational because the new information technologies will not fundamentally alter differences of opinion, beliefs, and values.'' What system dynamics in a collaborative approach allows us is the opportunity to explore the interrelationships (e.g., feedback loops) that may be created when we make decisions based on one integrated set of information and values compared to another set. Allowing participants to 'see' from another perspective or to see issues that they had not otherwise considered may help alleviate some of the 'prisoner's dilemma' scenarios so common in navigating complex policy decisions. This then, may allow a revised notion of collaboration in the actual decision-making process, whereby the collaborative effort is in building a tool, rather than explicitly in making a policy decision. The collaborative modeling approach will not lead to the idealized comprehensive policy process described by Lindblom (1959) and applied in many public policy textbooks. It can, however, provide for more intelligent ''muddling through'' (Lindblom 1959, 1979) and perhaps allow us to stop muddling on some issues and make a great leap.

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