DEVELOPING AN INTERPRETIVE DIALOGUE FOR GROUP MODEL BUILDING[†]

Aldo A. Zagonel
Nelson A. Rockefeller College of Public Affairs and Policy
University at Albany, State University of New York
E-mail address: Zagonel@aol.com

Proceedings of the 22nd International Conference of the System Dynamics Society
Oxford, England, July 25-29, 2004 (Draft dated July 2004)

This paper builds upon a review of the literature in group model building exploring the tension between modeling as a representation of reality –models as micro worlds, and modeling as a tool for negotiating a social order –models as boundary objects (Zagonel 2002). This line of research advocates a particular view: there are tensions in group modeling, and these tensions may be identified and characterized by differentiating micro-world from boundary-object approaches in model building and use. It builds upon the premise that tensions in model conceptualization exist, and that they are important for theory and practice. This paper suggests ways of operationalizing the identification and characterization of these tensions, and it reports the results of applying this framework to a small sample of documents from one intervention.

Key words: Group model building, system dynamics, decision conferencing, competing values approach, problem identification, problem definition, system conceptualization, model conceptualization, micro world, boundary object, coaching instruments, clinical supervision.

Introduction

This research builds upon the premise that, there are tensions in group model building (GMB) stemming from two competing views, denominated "micro-world" and "boundary-object" approaches to model building and use.[1]

For our purposes, the micro-world[2] approach to model building and use is defined as an analytical exercise resulting in a persuasive argument, of the kind that "speaks truth

---

[†] I would like to acknowledge and thank several contributors. David Andersen promoted my research through its several stages of development. Mohammad Mojtahedzadeh and Silvia Ulli-Beer made numerous suggestions that I readily incorporated. Members of my dissertation group, Luis Luna, Ignacio Martínez, Michael Deegan and Birgit Kopainsky, helped me in framing this pilot study and bringing closure to my dissertation effort. I would also like to thank comments received from Laura Black, Irene Lurie and George Richardson, as well as Rod MacDonald's help with testing my coding instruments.

[1] The terms micro world and boundary object are used metaphorically in this line of research, as defined in this paper and in Zagonel (2002), without much concern regarding their strict meanings as social-scientific concepts. Their genuine meanings and origins are discussed in the footnotes that follow.

[2] The term "microworld" was coined at the MIT Artificial Intelligence Laboratory in the early 1970s (Lawler 1987), and was popularized by Seymour Papert in his book *Mindstorms: Children,*

to power" (Sterman 2000). It is the pursuit of a model that objectively represents the operation of the real world (Randers 1980-B), to see if the modes of behavior depicted by the model could exist and whether or not they result from initial assumptions (Forrester 1961). This modeling aim requires theoretically and empirically based representations of constructs and relationships (e.g., Rudolph and Repenning 2002), and dogmatic or disciplinary acceptance of an inter-subjective reality (Barlas and Carpenter 1990). Modeling begins with a clear definition of the problem at hand, and a dynamic hypothesis that provides a structural feedback-rich causal explanation for the problematic behavior (Randers 1980-A, Sterman 2000).

According to this view, model building and use serves the purpose of objectively understanding the "functioning" of the system, in order to examine policy alternatives and reveal their projected consequences for evaluation and recommendation (Richardson and Pugh 1981). Micro-world model building and use often results in insightful lessons (Forrester 1969, 1971, 1975; Roberts 1978; Richardson 1996). However, because they may be confined to the knowledge and ownership of the analyst, or contradict dogmatic and disciplinary views of others (e.g., Brewer and Hall 1973, Nordhaus 1973, Forrester *et al.* 1974), model based learning may have little or no impact upon actual decision-making and change (Zagonel 2002).

In contrast, here, we define the boundary-object[3] approach as a social exercise in consensus building involving the stakeholders themselves. The purpose of the modeling

---

Computers, and Powerful Ideas (1980) –where the author discussed the possibilities of an emerging synergy between computer environments and mathematical pedagogy. Papert used the term in the context of a computer-based learning environment called "Logo" –in which children could program the environment, see how it responded, and draw out their own understanding of the principles of mathematical relationships. It means, literally, a tiny world inside which one can explore alternatives, test hypothesis, and discover facts that are true about that world. In system dynamics, the term is commonly used in the context of models operated via user-friendly interfaces, so called management flight simulators (MFS) –some examples are People Express, Boom and Bust, and Fish Banks. They can also be referred to as "learning environments". Sterman (2000) uses the term "virtual world" to address the model behind a MFS (pp. 35 and 83). For more information, see also Morecroft, Bakken *et al.*, Isaacs and Senge, Davidsen, Diehl, and Eberlein and Peterson –all chapters in Morecroft and Sterman, eds. (1994), as well as the following web pages: http://web.mit.edu/jsterman/www/, http://www.unh.edu/ipssr/Lab/FishBank.html, http://www.johnsaunders.com/papers/mfs.htm, http://www.gardenwithinsight.com/help100/00000508.htm, and http://www.rand.org/publications/RB/RB3037/.

[3] The term "boundary object" is fairly new to social science. It was first developed by Star (1989) to describe objects that are shared and shareable across different problem solving contexts (Carlile 2002). Boundary objects bridge the gap between two epistemic cultures and allow those two cultures to exchange valuable information and solve problems. Carlile (1997) suggested that models constitute one type of boundary object –as representations that can be observed and then used across different functional settings. According to the author, boundary objects can make embedded and tacit understanding of an individual's practical knowledge accessible, visible and explicit to others (Black *et al.* 2000). The idea of using simulation models as boundary objects was introduced even more recently by Black, Carlile and Repenning (2000). The authors

effort is to provide a venue for negotiation and alignment to occur among problem owners and decision makers, adding rigor to the discussion, providing means to keep track of complex causal structures, and serving as a memory of the group's understandings (Huz *et al.* 1997, Vennix 1999). This modeling aim draws upon "concepts in use" that are derived from the knowledge and perspectives of key stakeholders in the system, to develop a shared understanding or theory. The model contains the group's consensus about the important variables in the system, and the perceived mutual influences and causal relationships between these variables. In sum, the model becomes the group's representation of the participants' fragmented and subjective views. It is an agreed upon inter-subjective reality for the stakeholders involved in the effort, i.e., a boundary object that they create, shape and share (Black *et al.* 2000).

The boundary-object approach to modeling does not require everyone in the client group to hold the same view of the problem at hand. Instead, the starting point is a "messy" issue characterized by lack of common understanding among key stakeholders (Ackoff 1974, Eden *et al.* 1983, Vennix 1996). Group modeling serves the goal of leading the group toward agreed-upon definitions of key issues and dilemmas (Vennix 1999). It serves the purpose of advancing shared understanding about the system, identifying stakeholder interdependencies, framing, highlighting and addressing issues, examining policy alternatives and building consensus and momentum toward decision making, action taking and change (Eden *et al.* 1983, Quinn *et al.* 1985, Phillips 1986, Eden 1989, Reagan *et al.* 1991, Richardson and Andersen 1995, Bryson and Finn 1995, Vennix 1996, Vennix *et al.* 1997, Andersen and Richardson 1997). However, because boundary-object modeling may lack systematic checks with external sources of data, model based analysis may result in poor decisions with unintended consequences (Zagonel 2002), a phenomenon commonly referred to as "groupthink" (Janis 1982) – taken to mean that the group arrived at a mistaken consensus.

We assume both perspectives to be equally important. We acknowledge they are used in diversity of mixes, and with dissimilar emphases in different loci of theory and practice. This line of research deliberately clarifies and distinguishes them through a meticulous qualitative exercise of identification and characterization of each perspective, describing them as ideal types.

We also accept the thesis that group model building is a multithread approach combining policy analysis and decision making (Zagonel 2002). It combines the skills and tools involved in building both micro worlds and boundary objects. However, often

---

proposed that the effectiveness of formal SD modeling interventions could be dramatically improved, if the iterative process of model building were perceived as an effort in building a boundary object. They also drew a parallel with group model building (Richardson and Andersen 1995), where the model becomes a "concrete, tangible representation" of the issues at stake in the terms of the people involved. For more information, see also Star and Greisemer (1989), as well as the web page http://www.deregulo.com/facetation/pdfs/719_finalPaper_boundaries_goodall.pdf.

these skills and tools –and their analytical traditions– can be at odds with each other. Therefore, effective model building and use requires constantly balancing and integrating these two modeling approaches in the pursuit of *consensual learning*, commonly referred to in the literature as "team learning" (Senge 1990, Morecroft and Sterman 1994, Argyris 1999). Team learning is increasingly valued as a vehicle to achieve sustainable organizational change.

While these premises have not been empirically derived or tested, we think there is ample evidence of their existence in the system dynamics (SD) literature. Drawing upon organizational theory, Black *et al.* (2000) suggested that the process of building a dynamic model could serve as a boundary object, providing a process for groups to overcome obstacles posed by different individual perspectives. We find tradeoffs in *quantitative vs. qualitative SD modeling* (Coyle 2000, 2001; Homer and Oliva 2001; Powell and Coyle 2002; Graham 2002), *hard vs. soft systems thinking* (Winch 1993, Richardson *et al.* 1994, Forrester 1994), and *academia vs. practice* (Akkermans and Romme 2003, Hines 2003) to be obliquely related to the tensions discussed in this paper. In group model building, these tensions were acknowledged implicitly as far back as the inauguration of the approach (Stenberg 1980). Richardson and Andersen (1995) addressed them arguing in favor of different roles –and "teamwork"– for multiple members of a modeling team. Vennix (1996) revealed how difficult building insightful models with groups can be, requiring not only advanced skills in the modeler's arts and sciences, but also adequate handling of interpersonal communications, group processes, and human relations (Richardson 1999). These tensions have been noted also from an outsider's perspective of the field (Jackson 1994).

Similar tensions have been experienced and researched in related fields (Parsons 1959, Berger and Luckmann 1966, Burrell and Morgan 1979, Ackoff 1979, Taggart and Robey 1981; Eden 1990). Zagonel (2002) provided a rough overview of an elaborate framework with considerable empirical support, balancing four decision-making perspectives: political, rational, empirical, and consensual (Quinn and Rohrbaugh 1983; Quinn *et al.* 1985; McCartt and Rohrbaugh 1989, 1995; Rohrbaugh 1989, 1992; Rohrbaugh and Eden 1990; Reagan and Rohrbaugh 1990). The diagrammatic displays contained in the latter part of this paper –drawing upon this Competing Values Approach (CVA) framework– suggest how our research could evolve in this direction. Alternatively, Lane (2001-A, 2001-B) drew a parallel perspective based upon Burrell and Morgan's framework, and proposed using system dynamics, in the context of the agency/structure debate, to unite the human agent view of the social realm with views that concentrate solely on system structure, by providing a formal approach for explicating social mechanisms.

Purpose of this pilot study

This research draws upon interpretive dialogues, and diagrammatic displays to bring each perspective to life and to provide illustrations. Although this exercise may seem artificial, we think it is a necessary first step to understand competing values, key points of tension, and polar forces that create and give shape to these alternative points of view.

We believe this understanding will provide guidance to develop theory aimed at improving the balance of these two approaches in group model building, as well as to develop principles and heuristics for skillfully intertwining them in practice.

This pilot study is based upon a select subset of seven pieces of evidence from one case. We examine this evidence using two pairs of theory-generated lenses based upon each of the ideal-type dichotomous perspectives. Thus, the evidence is "selectively" examined and interpreted. The dialogue is created to enrich and bring to life our previously reported theoretical argument, extracted from normative and prescriptive literatures using the same dichotomous lenses (Zagonel 2002). We wish to make the dual argument not only vivid, but also less abstract and more concrete, to the extent that the argument will shift from theoretical principles to pragmatic application.

This phase of the research constitutes a preliminary attempt towards developing instruments, tools, and procedures to help scholars and practitioners gain awareness and monitor where a specific script, case, practice or approach is situated in the micro-world vs. boundary-object continuum. This paper contributes to GMB literature by helping observe and measure these tensions. Here, we describe how these instruments were developed and used; we list lessons learned from carrying out this effort, and reflect on the effectiveness, efficiency and usefulness of this line of research. This pilot study is a contribution to the effort to create objective knowledge and guidance to help move the field from craft to science (Andersen *et al.* 1997).

Background information

This research drew upon a well-documented large-scale project in which the author was a participant observer (Rohrbaugh 2000, Zagonel *et al.* 2004). Group model building was used to inform welfare reform policy making, drawing upon the perspectives and knowledge of key welfare service providers. During this project several SD models were built and used to experiment with management strategies and to explore scenarios. Zagonel (2003) provided a synopsis of the design and products of this intervention – which unfolded over a period of 22 months, and involved three counties in New York State. That paper addressed the policy aspect of the research, and focused upon documenting the models elicited, built, simulated, evaluated, tested and extensively used throughout the intervention.

During this experience as a hands-on apprentice in group model building, the author began to perceive difficulties in building SD models in the context of groups of stakeholders. Based upon a review of the GMB literature tracing its genealogy back to the 1960s, Zagonel (2002) substantiated a thesis arguing for the existence of two intertwined threads in the group approach to SD modeling: GMB interventions strive both to create a shared understanding of an interpersonal or inter-organizational problem, in the form of a boundary-object model, and to build a micro-world type model that is useful in terms of organizational redesign. Although not perfectly aligned, these two threads showed some overlap with two genealogical traditions, one with a "decision" focus and the other with a "policy" focus, decision conferencing and system dynamics,

respectively. Decision conferencing building upon group dynamics, decision analysis and decision support; system dynamics based upon servomechanisms engineering.

This pilot study draws upon the project archives for an empirical basis, and the literature review for a theoretical framework, as summarized below:

Empirical basis

A detailed overview of the schedule and streams of activities of the project is provided in Zagonel (2003) –see also Appendix 1. This pilot study looks at the first stream of activities –the development of the TANF model in Cortland County (see also Rogers *et al.* 1997). More specifically, we examine documents corresponding to the first five-week period, February 11 through March 18, 1997 –somewhere in the neighborhood of five to ten[4] percent of the full volume of the archives. This includes three full days of GMB meetings, and in-between meetings at the home office, in preparation for the client-group meetings.

We draw upon these materials, and our experience derived from the case, to observe and produce the interpretive dialogue for group model building reported in this paper. Specifically, we examined seven items containing project notes and documents, as summarized in Table 1.

[4] Most of the activities in the project occurred during the first half of the 22-month period.

Table 1 – Short summary of the seven records examined in the pilot study

Record number	Chronology	Type of record	Record identification	Number of pages	Purpose of document or event	Type of meeting	Duration of meeting (hours)	Number of persons in attendance
R-01	(March 3)	Contract	Project proposal	8	Project subject, purpose, method and deliverables	n.a.	n.a.	n.a.
R-02	*Feb 11*	*Report*	*Issue elicitation meeting*	*17*	*Problem identification and definition*	*Client team*	*7.0*	*17*
R-03	Feb 25	Minutes	Organizational meeting	5	Project overview and assignment of tasks	Modeling team	2.0	4
R-04	Mar 7	Minutes	1st preparation meeting	10	NYS welfare reform policy issues	Modeling team	2.0	5
R-05	Mar 12	Minutes	2nd preparation meeting	6	Process and scripts	Modeling team	2.0	6
R-06	Mar 13-14	Minutes	3rd preparation meeting	15	Three-layer concept model	Modeling team	2.0	3
R-07	Mar 17-18	Report	Model conceptualization meetings	31	Model conceptualization	Client team	14.0	26

The records examined include the project proposal (R-01), two electronic reports of full day meetings with clients (R-02 and R-07), and the hand-written minutes of four preparation meetings (R-03, 04, 05 and 06). The documents address problem identification and definition, and model conceptualization –representing the initial steps of the modeling process for the first of many models built for this intervention:

- The proposal (R-01) specified the purpose, method and deliverables of the project;
- Record 2 documented the issue elicitation meeting with the client team;
- Records 3 through 6 contain the minutes of modeling team meetings conducted at the home office without client participation. These were organizational meetings in preparation for model conceptualization. These meetings covered several issues: project overview and assignment of tasks, NYS welfare reform policy issues, process and scripts definitions, and development of a three-layer concept model to use as a starting point to the conceptualization exercise;
- Record 7 documented the model conceptualization meeting with the client team.

The documents range from 5 to 31 pages in length –a total of 92 pages, with the longer documents being the two reports of the client meetings: one-day issue elicitation meeting (17 pages) and two-days model conceptualization meetings (31 pages). We examined a total of 61 hours of meetings. While client meetings were roughly seven hours long (full day meetings), modeling-team meetings lasted between one to two hours each. The number of full-fledged participants in client meetings ranged from 11 to 13, but including

observers and members of the modeling team, this range expanded to 17 to 26 people. Modeling-team meetings counted with three to six participants.

Appendix 2 contains more details regarding these records, including an outline of the contents found in each of the documents. These records do not capture *individual* time spent working outside of the meetings, negotiating and preparing the proposal, preparing scripts for the client meetings, writing reports or developing the concept models. However, they do represent a total level of effort of 519 persons-hours of project activities, and about 16 percent of the client group meetings.[5] In this paper we draw extensively upon Record number 2 to illustrate the tools and procedures developed and used in this pilot study.

Theoretical framework

We used the literature-based theoretical framework distinguishing micro worlds and boundary objects as a starting point to develop coding rules for classifying the content of the project archives. Zagonel (2002) identified eight tension points in problem identification and definition, and model conceptualization. We built upon initial identification of two polar forces for each tension point, as summarized in Table 2.

PROBLEM IDENTIFICATION AND DEFINITION. The tension points in problem identification and definition are related to three key aspects in any SD model building effort: *problem*, *purpose* and *client/audience* (Richardson and Pugh 1981), as well as the issue regarding *synthesis* in problem definition.[6]

- In the **micro-world** approach, the modeling effort is perceived as a *problem solving* exercise, where the work is done for a single client or a "*monolithic*" audience. The problem is perceived as "*preexisting*," clearly defined and synthesized in the form of a *dynamic hypothesis* that proposes to explain it.

- In the **boundary-object** approach, the problem cannot be easily defined because it is perceived as *messy*, involving many issues. This results from the nature of the problem itself, and/or the fact that the audience is made up of stakeholders representing different interests and *constituencies*. The modeling effort is perceived as a *consensus building* exercise, to expose and understand the different values, perspectives and objectives embraced by members of the client group, and to build collective momentum toward decision making. In order to achieve this purpose, the problem is broadly (or even ambiguously) defined at first, and *no attempt is made to synthesize it* prior to model conceptualization.

[5] We coded and recorded three (out of the nineteen) full-day client group meetings carried out during the project.

[6] We highlighted the constructs for the "tension points" and "polar forces" in the text and in Table 2 using *Italics*.

Table 2 – Dichotomous view of models in group model building
(Resulting from the review of the literature – Zagonel 2002)

Problem identification and definition:

Tension points	Polar forces (extremes)	
	Models as "micro-worlds"	Models as "boundary-objects"
1. Nature or context of the ***problem***	Problem is perceived as ***preexisting***	Situation is perceived as ***messy***, involving many issues
2. ***Purpose*** of the modeling effort	***Problem solving***	***Consensus building*** and decision making
3. Type of ***client/audience***	Single client, ***monolithic***	***Constituencies***, stakeholders
4. Form of ***synthesis*** in problem definition	***Dynamic hypothesis*** reflects a synthesis of the problem	***No synthesis*** is attempted in problem definition, multiple issues, ambiguity

Model conceptualization:

Tension points	Polar forces (extremes)	
	Models as "micro-worlds"	Models as "boundary-objects"
5. ***Intrusiveness*** of the conceptualization framework	***Dynamic hypothesis*** used to guide conceptualization, emphasis on deduction	***Non-intrusive*** approach to conceptualization, emphasis on induction
6. ***Objectiveness*** of the information used to conceptualize the model	Conceptualization based upon ***established theory and factual information***	Conceptualization based upon ***views and opinions*** of clients, expert judgments
7. Definition of ***model boundary***	Model boundary is ***parsimonious*** and ***guided*** by the dynamic hypothesis	Model boundary is ***broad*** resulting from ***negotiation process***
8. ***Role of the modeler***	Modeler acts as a ***reflector*** or expert	Modeler acts as a process ***facilitator***

MODEL CONCEPTUALIZATION. The tensions points in model conceptualization are related to the *intrusiveness* of the modeling framework or approach, what is perceived as useful information in model building (the *objectiveness* of information), what guides *model boundary* decisions, and the *role of the modeler*.

- In the **micro-world** approach, the *dynamic hypothesis* coming out of problem identification and definition is used to guide model conceptualization, and to govern model boundary decisions (*guided/parsimonious*). The modeler acts as an expert, and draws extensively upon her abilities as a "*reflector*" to influence the conceptualization effort. In order to validate the model, the modeling effort is based upon established *theory and factual* information. All causal relationships in the model, parameter estimates, and table functions are justified in terms of their objectivity –i.e., they are real, unbiased, not influenced by personal feelings, and exist without regard to thought or imagination.

- In the **boundary object** approach, a high value is placed on adopting a modeling framework that is *non-intrusive*, to allow the issues to be discussed without framework-induced bias. For this reason, the modeling effort is *not* anchored in a dynamic hypothesis, and the modeler's role is defined narrowly as that of a process *facilitator*. The modeling effort is based upon *views and opinions* of clients (sometimes in the form of expert judgments). Model boundary is *broad*, resulting from a facilitated *negotiation* process. The model is "valid" to the extent that the client-group perceives it to be a good representation of their shared understanding, and the group is willing to make decisions and take action based upon this understanding and representation.

This literature-based theoretical framework was developed only for the first two steps of the modeling process (problem identification and definition, and model conceptualization). However, an initial illustration used as point of departure for examining the literature suggested what they might look like for all of the steps (see Table 3 in Zagonel 2002, reproduced here as Appendix 3).[7]

Method

This line of research deliberately clarifies and distinguishes micro-world and boundary-object approaches to model building and use, through a meticulous qualitative exercise of identification and characterization of each perspective, describing them as ideal types. It draws upon an interpretive dialogue to bring each perspective to life.

[7] Contrasting Table 2 with Appendix 3, we find differences between the tension points (and polar forces) resulting from the literature review, as opposed to the illustrations that helped guide it. In general, the process of reviewing the literature revealed more points of tension than anticipated, and enabled refinement of the original assumptions about them and their polar forces.

We use interpretive dialogues as in a *dialectic*[8] –in which characters, playing ideal-type roles, argue from the available evidence, advocating particular points of view. "Caricatured" actors describe what they see when looking at notes of group modeling meetings and key project documents. The dialogues are not intended as neutral descriptions of the evidence, but "tinted" descriptions, biased by the individual frames of reference of the characters describing and discussing the events (either based on the micro-world or boundary-object metaphor).

A similar approach was used by Allison (1971) –in his influential book on the Cuban missile crisis. Except, he wrote three separate stories, each based upon an alternative perspective to, later, sum up the differences in interpretation in a concluding chapter. Allison argued there was value in this approach because "by comparing and contrasting the three frameworks, we see what each magnifies, highlights, and reveals as well as what each blurs or neglects" (p. v). The author demonstrated how alternative conceptual lenses lead one to see, emphasize, and worry about quite different aspects of events. This is exactly the objective of this line of research: to bring visibility to the inherent tensions in pursuing each of the two modeling objectives, micro worlds vs. boundary objects. Except that here it is done in the form of a discussion or debate.

A closer parallel can be found in Richardson (1991) –where issues and implications of feedback thought in social science and systems theory are discussed in two arguments "teased out" by the cybernetics and servomechanisms perspectives. In this case, the author uses "partisan presentations" to offer "opinionated statements," written from the perspective of "a devotee" of the appropriate feedback thread. Richardson draws upon these two caricatured characters to point out weaknesses in the other thread's development of the feedback concept, and to boast about the corresponding strengths of their own threads (pp. 320-322). He warned the purpose "is not controversy but clarity about the current state of the evolution of feedback thinking in the social sciences" (p. 321). In our case, the purpose also is not to raise controversy, but to identify and characterize key tensions that surface when the two modeling approaches are intertwined.

Although we do suggest some ideas for resolving tensions, we have not gone as far as to find solutions. In this paper we mainly describe the development of the instruments and tools to operationalize the identification and characterization of these tensions, and report the results of applying this framework to a small sample of documents. Our method borrows heavily from guidelines and techniques developed for content analysis (Berelson 1952, Gerbner *et al.* 1969, Carney 1972, Rosengren 1981). We also considered methodological issues from field research (Gold 1969, Glazer 1972),

[8] Our interpretive dialogue is similar to the "dialectic" –a method that can be traced back to Georg Wilhelm Friedrich Hegel (1770-1831) and Karl Marx (1818-1883). Dialectic is seen as an argument that is structured in a thesis, an antithesis and a synthesis. For example, the thesis would say that an educator is like a sculptor, and the antithesis would argue that the educator is like a gardener. The synthesis would conclude that the role of the educator could only be characterized discussing both opposite arguments and intertwining them.

and archival analysis (Webb *et al.* 1966). We draw upon these multiple methods in social research to complement each other (Babbie 1992), rather than to triangulate results (Brewer and Hunter 1989).

In carrying out this pilot study, we iterated around seven steps. What follows is a description of these steps and how they are interrelated:

Step 1: Identification of key tension points and polar forces

Table 2 summarized our conceptual framework containing eight tension points derived from the review of the literature. There was much iteration between the original tables in the conceptual paper (Zagonel 2002) and this summary table. These iterations resulted from labeling and re-labeling the tension points and their polar forces as the coding rules were developed and used. In revising the labels, we pursued simplicity and clarity in the identification and characterization of the tension points and their polar forces. We feel this is still work in progress and improvements could be made. However, the labels used in Table 2 represent the state of the art of this research.

Step 2: Development of coding rules

The goal of coding rules is to provide guidance for coding and recording. They further describe and define the labels given for the tension points and polar forces. The coding rules provide information on how to interpret or apply the labels. Initial rules were extracted from the literature review to synthesize key aspects identifying and characterizing each side of the dichotomy. We also borrowed some ideas from the best practices work of Martínez-Moyano and Richardson (2002). The coding rules were regularly updated to make the constructs more specific and clear as progress was made in coding.

The coding rules were found to be especially important when assessing inter-coder reliability. Reliability will be necessarily low if the coding rules are not clear, or are not interpreted in the same manner by all coders. Also, here, improvements could be made.[9]

Step 3: Development of coding sheets

We tried several different alternatives for coding. First, we coded directly on the documents themselves, without using coding sheets. After applying the codes to the document, the information was transferred (recorded) directly onto a spreadsheet. At this early phase, with the coding rules still at a stage of development, some of the information that was coded and recorded in the spreadsheets was later found to be invalid or unreliable. This early exercise in coding and recording resulted in two measures. We decided to break up the documents into separate sections. We also developed "summary" coding-sheets that could be used by multiple coders. This new system allowed us to

[9] Appendix 4 documents a pre-test of inter-coder reliability.

assess inter-coder reliability. Bringing on other coders required quite a bit of work on improving the coding rules.

After a pretest was conducted –drawing upon two other coders, and using better developed coding rules– the process of coding continued to be carried out only by one coder, the author, who felt it was unnecessary to continue breaking up the documents into separate sections. Once again, the codes were noted directly on the documents themselves. However, instead of continuing to use a spreadsheet to record and aggregate the results, a "detailed" coding-sheet was devised to capture the results of the coding for each document examined.[10]

Step 4: Defining characters and roles

We knew from the beginning that we wanted to draw upon two "caricatured" characters representing each side of the ideal-type dichotomy. We decided to call one ***Ms. Micro World (MW)***, and the other ***Mr. Boundary Object (BO).*** These two characters had two tasks. First, coding the documents using their separate lenses to hone in on the micro-world and boundary-object features contained in each of the documents, and reporting these results in the coding sheets. (Of course, in fact, the author drawing upon the coding rules and using both lenses did this task.) Second, the characters had to describe what they saw taking place, based upon what they picked up from the documents, and carry out a discussion highlighting the features they saw (or expected to see but didn't) in the documentation. (Again, the author carried out the task of writing both sides of the argument.)

Later we realized that we needed two more characters playing two other roles. We needed a ***moderator*** for the discussion, someone who could introduce the document being discussed, summarize the panel's findings, and act as a neutral voice in the debate. We also needed someone who was actually present during the intervention to provide information that was not available in the document itself. This actor would provide to the discussion a ***participant***'s perspective. It was then that we realized that the ***participant*** was really the reason why the panel of experts was being brought together. The character represented the author and his interest in substantiating these juxtaposing views (of micro worlds vs. boundary objects), convening the panel to seek help from two opposing experts.

The ***participant*** (author) would have the role of pushing the debate in the direction of some constructive criticism, aimed at improving GMB theory and practice. This is because there was no expectation that either ***Ms. MW*** or ***Mr. BO*** would ever come to an agreement. That was the whole point. They should forever disagree, since they were designed to hold diametrically opposed views on every dimension of the issues under scrutiny. Their jobs were to accentuate the conceptual distinction, finding

[10] We report both types of coding sheets in this paper: in the body of this paper, we show and illustrate "detailed" coding-sheets; in Appendix 4, we show and illustrate a "summary" coding-sheet.

empirical evidence for their positions in the documentation, and making the distinctions as vivid as possible. If this debate were to be about more than raising controversy, we needed a character to suggest forms of synthesis (or resolution) for the arguments, and to bring closure to the conflicting views; no one better than the author, playing himself, to attempt to do so.[11]

Step 5: Coding and recording

The seven documents examined in this pilot study were coded and recorded in different phases of development of the coding rules and coding sheets. Records 1 and 7 were coded using the earlier system, in which the codes were applied directly to the document itself, and the recording was done in detail onto a spreadsheet. Record 2 was coded using the "summary" coding-sheet. These documents were revisited when the "detailed" coding-sheet was adopted. Records 3, 4, 5 and 6 were coded directly using the final procedures and tools described and illustrated in the body of this paper.

All seven records examined have been coded and the results recorded in "detailed" format. Record 2 is illustrated in the section entitled "Detailed coding-sheets". The results for the other records are contained in Appendix 6.

Step 6: Reporting findings in interpretive dialogue format

Interpretive dialogues were written for Records 1 and 2. The dialogue regarding Record 2 is in the body of this paper; the dialogue regarding Record 1 is reproduced in Appendix 7. The detailed coding-sheets in and of themselves report findings. But the discussion is where the findings are given interpretation by the two panelists. The attempts made to propose synthesis, resolution or closure to these opposing arguments, or to suggest ways of intertwining the two modeling approaches to improve GMB theory and practice, can be found in the voice of the ***participant*** (author).

We found this exercise extremely hard and challenging. There is a dangerous tendency to oversimplify the argument, and to allow the discussion to turn into a "Straw Men" argument.[12] Also, it is quite easy to become tediously repetitive, raising the same

[11] The task of defining characters and roles lead to an interesting discovery about the meaning of colors. Appendix 5 suggests how the colors green, yellow, blue and red can be used to help define and clarify the roles of each of these four characters.

[12] This discussion *should be* different from a Straw Men argument in the sense that each panelist is asked to take an extreme position, as opposed to distort the other panelist's position to the extreme: "The Straw Man fallacy is committed when a person simply ignores another's actual position and substitutes a distorted, exaggerated or misrepresented version of that position" (http://www.nizkor.org/features/fallacies/straw-man.html). The extreme positions, represented by ***Ms. MW*** and ***Mr. BO,*** are ideal types that do not actually exist. Instead, they are simply caricatures that serve the purpose of revealing points of tension in pursuing both approaches to model building. They *should* provide the lenses to identify pieces of evidence in the documentation (or to note absences), and to tease out an interesting *and constructive* argument. However, it is easy and tempting to wander off into the Straw Man fallacy. On the other hand, it

controversy over and over again. Therefore, a sense of discomfort quickly set in as these dialogues were being constructed. Rather than continuing on the path of writing these dialogues for the full set of documents coded and recorded, we decided to explore an alternative format to report our findings and to generate a constructive discussion.

Step 7: Reporting findings in diagrammatic displays

This last step was not envisioned at the beginning of this research, but seemed like a natural development, inspired in the CVA framework, briefly summarized in the Zagonel (2002). We find that the diagrammatic displays further characterize the competing perspectives through graphic illustrations. This step also represents some progress in the direction of quantifying the tensions.

Coding rules

Table 3 reports the state of the art of the coding rules for the micro-world vs. boundary-object dichotomy. For example, the concept of the dynamic hypothesis appears twice on the micro-world side of the dichotomy. *Dynamic hypothesis 1* (code "G") should be interpreted as:

> The facilitator and/or the modeler … "pursued synthesis in problem definition; s/he (they) rephrased causal stories (told by participants) as 'this (problematic) behavior is caused by that structure'."

On the other hand, *Dynamic hypothesis 2* (code "J") should be interpreted as:

> The facilitator and/or the modeler … "used dynamic hypotheses to conceptualize the system; s/he (they) pursued major causal loops hypothesized to determine the behavior of key variables; s/he (they) adopted a deductive, top-down approach (to conceptualize the model)."

---

is quite challenging to hone in on "key" disagreements, and to address them constructively and successfully.

Table 3 – Coding rules for micro world vs. boundary objects dichotomy

Problem identification and definition:

Problem	
A) Preexisting – Specified an objective problem statement; identified the problem as a central "process" or time development to be studied; drew problematic historical patterns; engaged in modeling "the problem".	B) Messy – Acknowledged that many issues are involved (even if implicitly); accepted broadly stated problem definition(s); engaged in modeling "the system".
Purpose(s)	
C) Problem solving – To solve a specific problem through feedback learning and system's redesign. Emphasized understanding the dynamic complexity of the problem or learning feedback-rich insights regarding problematic behavior(s).	D) Consensus building – To align individual mental models toward shared understanding, consensual views or decisions (visions, goals, objectives or strategies). Emphasized consensus building on a shared view of the system or client-group ownership of modeling products.
Client/audience	
E) Monolithic – Worked for a single client or a client group with strong leadership or shared vision regarding problem and purpose definitions.	F) Constituencies – Worked with a diverse group of stakeholders or with a group with broad views of issues; worked with a group with dissimilar views of the purpose(s) of the modeling effort.
Synthesis?	
G) Dynamic hypothesis 1 – Pursued synthesis in problem definition; rephrased causal stories as "this (problematic) behavior is caused by that structure" (similar to code 5).	H) None – Defined problem/purpose broadly; discussed behavior loosely coupled with structure (or vise-versa).

Model conceptualization:

Intrusiveness	
J) Dynamic hypothesis 2 – Used dynamic hypotheses to conceptualize the system; pursued major causal loops hypothesized to determine the behavior of key variables (similar to code 12); adopted deductive, top-down approach.	K) Non-intrusive – Provided some structure to provoke and guide discussions, but avoided restraining conceptualization with framework; changed "lenses"; adopted inductive, bottom-up approach (related to code 8).
Objectiveness	
L) Theories / facts – Elicited theoretical and factual knowledge; obtained hard data.	M) Views / opinions – Elicited views and opinions; worked with soft variables; used social judgments as data.
Boundary	
N) Guided / parsimonious – Pursued a parsimonious model including only dynamically relevant structures; focused conceptualization upon small number of stocks.	O) Negotiated / broad – Conceptualized using a large number of stocks; struggled with level of aggregation and scope issues; facilitated the negotiation of a shared view of the system.
Role of the modeler	
P) Reflector – Acted as analyst or teacher; brought in an outside perspective; focused primarily on insight.	R) Facilitator – Acted as learner; blended with the group; focused primarily on procedure (group processes or group dynamics).

This is an interesting example because it shows how the dynamic hypothesis has really two functions in SD modeling. On the one hand, it serves as a synthesis of problem definition; on the other, it serves as a guiding force to model conceptualization. Similarly, on the boundary-object side of this table, we distinguish between a broadly (or ambiguously) defined problem statement (coded as "H"), and a model conceptualization framework or approach that is non-intrusive (coded as "K").[13]

Coding rules for best practices

We found it useful to develop, in parallel, coding rules for best practices in system dynamics, adapted from Martínez-Moyano and Richardson (2002) –*because their survey of experienced system dynamicists contained detailed statements of best practices that could be borrowed and adapted, to help capture the constructs proposed as polar forces*. Table 4 reports the state of the art of the coding rules for best practices in system dynamics.

Appendix 8 illustrates how we relabeled thirteen best practices from the original statements formulated by Martínez-Moyano and Richardson. It also illustrates how we extracted coding rules from the statements contributed by the participants in the study. Although at first we did not intend to code the records for best practices, we decided to do it to identify which SD practices were emphasized in this GMB intervention. The flipside is that we also discovered areas of best practices that were underemphasized. *These discoveries were particularly useful to the micro-world side of the dialect.*

The coding rules should be self-explanatory to readers familiar with the SD method. Micro-world and boundary-object coding draws upon *letters* "A" through "R"; best practices coding draws upon *numbers* 1 through 13. Therefore, we will abstain from explaining them in any more detail. Instead, we will illustrate how we used the coding rules to code and record information in the "detailed" coding-sheets.

[13] While we hypothesize that "G" and "J" will most likely be found together, as well as "H" and "K", it is conceivable that they may be used interchangeably. For example, a first group modeling meeting focused upon problem identification –which may not have resulted in synthesis in the form of a dynamic hypothesis (coded "H")– could be followed by a second meeting –where the modeler proposes to pursue conceptualization based upon a dynamic hypothesis conceived without client participation (coded "J"). The opposite may also hold true, if the facilitator chooses to adopt a model conceptualization script that is non-intrusive (coded "K"), even though during a prior meeting the group did arrive at a synthesis in problem definition in the form of a dynamic hypothesis (coded "G"). Plausible reasons for the latter combination might be that the synthesis obtained in the previous meeting was premature, or it missed the "real" issue, capturing only a problem symptom.

Table 4 – Coding rules for best practices in system dynamics
(Adapted from Martínez-Moyano and Richardson, 2002; see also Appendix 8)

Problem identification and definition, Consensual:
1) Problem descriptions were sought – Asked questions regarding problems/issues; listened to understand the clients' problems/issues; rephrased the problems/issues.
2) The purpose(s) of the modeling effort were discussed – Defined the purpose(s) of the modeling effort (e.g. problem structuring, problem solving, system's redesign, policy/strategy exploration, consensus building, etc.).
3) Dynamics were depicted – Identified key variables of interest and drew reference modes of behavior, historical (actual or hypothesized) or expected (future projection).
4) Causal stories were sought – Asked what caused or is causing the behavior of key variables.
5) Dynamic hypotheses (1) were used to discuss behaviors – Rephrased causal stories as "this behavior is caused by that structure."

Problem identification and definition, Non-consensual:
6) Prior experience was associated to the modeling effort – Identified the class of systems to which the particular case belonged.
7) A generic model approach was suggested – Modeled (proposed modeling) the class to which the case belonged; de-emphasized the detail complexity of the case at hand.

Model conceptualization, Consensual:
8) Creativity and flexibility were employed – Approached conceptualization from different angles; avoided rigid separation of modeling steps (problem identification/definition, model conceptualization, formulation, etc.); recognized that conceptualization is creative (there are no recipes).
9) Conceptual building blocks were used to elicit mental models – Used SD tools (such as graphs of behavior over time, concept models, feedback loop diagrams, or stock-and-flow diagrams) to reveal the participants' mental models or engage the group in discussion.
10) Key stocks were used to focus conceptualization – Identified critical variables that characterize the state of the system.

Model conceptualization, Non-consensual:
11) Causal loops were sketched – Drew closed-loop diagrams around key variables.
12) Dynamic hypotheses (2) were crafted to guide formulation – Hypothesized major causal loops determining the behavior of the key variables.
13) Stock-and-flow structures were sketched – Drew structures depicting accumulations (e.g. resources, customers, products or services); identified influences on flows.

"Detailed" coding-sheets (research findings)

We will discuss the process, and illustrate the results, of coding and recording for Record number 2 –the issue elicitation meeting (Zagonel *et al.* 1997).

We followed a similar sequence of procedures in applying *both* "best practices" and "dichotomy" codes, and for recording results in the respective coding sheets:

1. Examine the document using the "best practices" codes and jotting down in the document itself the codes (*numbers* "1" through "13") whenever applicable;

2. Repeat the process for the "dichotomy" codes (*letters* "A" through "R"). (After working on this task for a while we found it easier to do first the "micro-world" side [A, C, E, G, J, L, N, and P], followed by the "boundary-object" side [B, D, F, H, K, M, O, and R].);

3. Complete the detailed coding-sheet for the "best practices" content. This task involved:

    a. Capturing in bullets transcribed statements combining the coding rules and the evidence observed in the document ("chunks for information"), in complete comprehensible assertions;
    b. Placing these assertions in the appropriate "buckets" of the coding sheet, i.e., under the appropriate category of code;
    c. Numbering (using Roman numerals) each of this assertions or "chunks of information";
    d. Recording with page numbers where they were observed in the document.

4. Repeat this process for the "dichotomy" codes, again doing first the "micro-world" side, and then the "boundary-object" side.

We illustrate with two examples, one for each set of codes.

BEST PRACTICES. For best practices content, we illustrate for the category of code number "8", denominated "creativity and flexibility":

Model conceptualization, Consensual:	
8) Creativity and flexibility	
viii.	Avoided rigid separation of modeling steps: preliminary steps at quantification (associated with model formulation) were taken for stocks and inflows (pp. 10, 14 and 17)
ix.	The Hopes & Fears exercise was a creative way to reveal the issues of concern to the participants (p. 5)

DICHOTOMY CONTENT. For dichotomy content, we illustrate for the tension point denominated "objectiveness" of information, for categories of code letters "L" and "M" – polar forces denominated "theories/facts" vs. "views/opinions", respectively:

Model conceptualization:	
Micro-world perspective:	Boundary-object perspective:
Objectiveness:	
L) Theories/facts	M) Views/opinions
xxix. The intervention was explained as an opportunity to put views and opinions through a *test* (p. 13), thus deriving more objective knowledge	xxx. Elicited views and opinions – the intervention was explained as an opportunity to help clarify and test *views* using a model built based upon the group's *assumptions* (p. 13) xxxi. Used social judgments as data – 33 "questimates" of current values of stocks and flows were elicited from the participants using nominal group techniques (pp. 10, 14 and 17)

This approach to capture and present the results of coding and recording has the following advantages:

- The "chunks of information" are complete comprehensible assertions that make sense without need to refer to the original document;
- These assertions connect the content of the document ("chunks of information") with the category of code ("bucket"). This is evident both in the statements themselves, as well as in the page numbers;
- If assertions are not related, they are recorded in separate bullets, reflecting the variety of observations pertinent to a particular category of code, as well as permitting a "count" that captures the quantity of unrelated observations made;
- The use of separate bullets helps to keep track of the quantity of unrelated observations;
- The Roman numerals allow the characters in the dialogue to substantiate their statements by referring to the individual items contained in the coding sheets through their respective reference numbers.

The draw back of this system is that it is *very* time consuming. For this document, tasks 1 and 2 took approximately two hours. Tasks 3 and 4 demanded approximately five hours. Therefore, the entire process of coding and recording took approximately seven hours (for this record containing 17 pages –i.e., nearly 30 minutes to code and record each page of the document). The full results for Record 2 are illustrated in detailed coding-sheets, in two pages for "best practices" content in Table 5, and in four pages for "dichotomy" content in Table 6.

Altogether, these two tables contain 33 observations, 11 regarding best practices content, and 22 regarding dichotomy content. In the next section, the four actors in the dialogue describe and analyze the substance contained in these tables. (In their argument, they will point out to most of these observations.)

Table 5 – Detailed coding sheet for best practices content (p. 1/2)
(Record 2: Issue elicitation meeting – February 11, 1997)

Problem identification and definition, Consensual:
1) Problem
i. The process of issue elicitation began with the use of a Hopes & Fears exercise, in which the participants were asked what they hoped the group could accomplish, and what they feared could go wrong. As individual contributions were made, the facilitator clustered the participants' ideas and extracted from them some major themes. The group diversely stated what they hoped to accomplish: managing change and the transition, promoting integration of services and cooperation among providers (aligning organizational missions to provide effective comprehensive services), strengthening recipients' families and personal responsibility, and improving cost-effectiveness in service delivery (lowering costs and improving results, helping clients attain self-sufficiency). The difficulties they feared were: client ineligibility, inability to provide services to people with special needs, inadequacy in current resources, conflicting missions among providers (resulting in clients falling through the cracks), and change itself (p. 5)
2) Purpose
ii. The county commissioner stated that the purpose of the intervention was to evaluate the impact of policy implementation decisions made by social services upon other providers, and the community in general (p. 4) iii. The facilitator stated that group model building would draw upon the participants to capture the spectrum of issues of interest to them, and their interrelations in the welfare system, and that modeling and simulation would help the participants to gain experience with how the system worked as a whole (p. 4) iv. A number of goals and objectives transpired from the Hopes & Fears exercise: to make the transition easier, to develop a strategy to move clients to work, to develop community-wide approaches to serve clients in need (integrating services, reducing fragmentation, increasing efficiency, clarifying turf and reducing duplication), to avoid an increase in the local tax burden, to investigate the effect of policy changes, and to assess resource needs (p. 5)
3) Dynamics
v. Graphs of expected/projected behavior over time (future patterns) were elicited for two resource stocks (employment and training dollars, and emergency service capacity), and two client stocks (single parents unemployed less than one year, and unemployed over one year) (pp. 11, 12, 15 and 16)
4) Causal stories
vi. The expected/projected dynamics were explained in terms of causal stories (pp. 11, 12, 15 and 16)
Problem identification and definition, Non-consensual:
6) Prior experience
vii. The experience of the modeling team with public sector issues was highlighted, in specific service delivery (p. 4)

Table 5 – Detailed coding sheet for best practices content (p. 2/2)
(Record 2: Issue elicitation meeting – February 11, 1997)

Model conceptualization, Consensual:
8) Creativity and flexibility
viii. Avoided rigid separation of modeling steps: preliminary steps at quantification (associated with model formulation) were taken for stocks and inflows (pp. 10, 14 and 17) ix. The Hopes & Fears exercise was a creative way to reveal the issues of concern to the participants (p. 5)
9) Conceptual building blocks
x. Used reference modes drawing to explore the participants' expectations of future patterns of behavior of selected stocks (pp. 11, 12, 15 and 16)
10) Key stocks
xi. Eleven stocks of clients and twelve stocks of services/resources were identified using nouns as variable names, and their units were specified (pp. 8, 10 and 17)

Table 6 – Detailed coding sheet for "dichotomy" content (p. 1/4)
(Record 2: Issue elicitation meeting – February 11, 1997)

Problem identification and definition:	
Micro-world perspective:	Boundary-object perspective:
	Problem:
	B) Messy
	xvi. Proposed to draw upon the group to capture the spectrum of issues and interrelations (in the system) (p. 4)
	xvii. Approached the situation as a messy problem involving many issues. The Hopes & Fears exercise did not produce consensus on what the main problem was (whether to manage the transition, integrate services, strengthen families or become more cost-effective). Instead, a number of issues were raised (regarding the challenge of change, and how it would impact the local tax base, clients, providers and employees; whether mandates and requirements could be met, such as successfully placing clients in jobs and helping them attain self-sufficiency) (p. 5)
	xviii. Chose to concentrate the modeling effort upon the TANF program (system), and Cortland's vision for its implementation (holistic assessment and placement, integrated client database, confidentiality and information sharing among providers, monitoring for results, etc. (p. 11)
	Purpose:
C) Problem solving	D) Consensus building
xix. Emphasized *understanding* dynamic complexity: the facilitator stated that modeling and simulation would help clarify and test the participants' views and assumptions about system-wide relationships and behaviors (p. 13)	xx. Several purposes were associated with the intervention: to evaluate the impact of DSS policy implementation decisions and to improve the participants' understanding regarding how the system works (p. 4); to address a number of issues and uncertainties, and to delineate the participants' goals and objectives, particularly those associated with TANF implementation (pp. 5 and 11), to promote cooperation, to achieve some degree of group consensus and commitment (see next point)
	xxi. Emphasized *consensus building*: the desire to align inter-organizational missions, goals, objectives and strategies in the implementation of TANF is implicit in the discussion (pp. 5 and 11), but the facilitator explicitly stated that group model building would help achieve some degree of consensus within the group (p. 13)

Table 6 – Detailed coding sheet for dichotomy content (p. 2/4)
(Record 2: Issue elicitation meeting – February 11, 1997)

Problem identification and definition: (Continued)	
Micro-world perspective:	Boundary-object perspective:
	Client/audience: F) Constituencies xxii. Worked with a diverse group of stakeholders: six people from social services, three from other departments (health, mental health and labor), one legislator, and one non-government representative – total 11 people (p. 3) xxiii. Worked with a group with broad views of the issues and of the purposes of the intervention. These different perspectives were welcomed and respected. No *one* specific issue or goal was embraced as the *key* problem or purpose to address in the intervention (p. 5) xxiv. More stakeholders (organizations) were identified as associated with the goals and issues specified for the intervention, to enrich viewpoints and possibly enlarge participation (pp. 6 and 7)
	Synthesis: H) None xxv. Defined problem/purpose broadly – a wealth of information was obtained: several visions/goals/ objectives were discussed, as well as issues of concern (pp. 5 and 11); stakeholders associated with those goals and issues were listed (pp. 6 and 7); key variables were identified, their units defined, their ongoing values estimated (pp. 8, 10, 14 and 17) xxvi. Discussed behavior loosely coupled with structure – some expected dynamics were drawn and discussed; short stories with causal explanations (but without causal diagrams) were offered (pp. 11-13 and 15-16)

Table 6 – Detailed coding sheet for dichotomy content (p. 3/4)
(Record 2: Issue elicitation meeting – February 11, 1997)

Model conceptualization:	
Micro-world perspective:	Boundary-object perspective:
Intrusiveness:	
	K) Non-intrusive xxvii. Provided some structure to provoke and guide discussions; changed "lenses" – divergent scripts were used to get the group to discuss issues freely from different angles (hopes & fears, stakeholder analysis, resource inventory, projections and scenarios) (pp. 5, 6-7, 8, 11-13 and 15-16) xxviii. Avoided restraining conceptualization with framework – formal aspects of the SD framework were not imposed in this meeting (such as causal-loop diagrams, stock-and-flow structures, and dynamic hypothesis), except for forcing the client group to select the units for stocks and naming them as nouns (pp. 8, 10, 14 and 17), and discussing the timeframe and focusing on the dynamics of some variables by drawing graphs of behavior over time (pp. 11-13 and 15-16)
Objectiveness:	
L) Theories/facts xxix. The intervention was explained as an opportunity to put views and opinions through a *test* (p. 13), thus deriving more objective knowledge	M) Views/opinions xxx. Elicited views and opinions – the intervention was explained as an opportunity to help clarify and test *views* using a model built based upon the group's *assumptions* (p. 13) xxxi. Used social judgments as data – 33 "questimates" of current values of stocks and flows were elicited from the participants using nominal group techniques (pp. 10, 14 and 17)
Boundary:	
	O) Negotiated/broad xxxii. Conceptualized using a large number of stocks (pp. 8, 10, 14 and 17) xxxiii. Struggled with level of aggregation and scope issues – a wide model boundary began to be delineated casting a very broad net, but goals and issues of concern were aggregated within the group (p. 5)

Table 6 – Detailed coding sheet for dichotomy content (p. 4/4)
(Record 2: Issue elicitation meeting – February 11, 1997)

Model conceptualization: (Continued)	
Micro-world perspective:	Boundary-object perspective:
Role of the modeler:	
P) Reflector	R) Facilitator
xxxiv. Brought in an outside perspective – asked the group to discuss timeframe, and focus on the dynamics of some variables by drawing graphs of behavior over time (pp. 11-13 and 15-16); revealed differences of opinion and areas of uncertainty	xxxvi. Acted as learner – learned as much information as possible from the collective knowledge of the group (…)
xxxv. Focused on insight – revealed as much information as possible from the collective knowledge of the group (goals, issues of concern, resource inventory, data estimates, and behavioral projections)	xxxvii. Focused primarily on procedure – the facilitator and process coach focused upon structuring and conducting the elicitation of ideas and information *to learn* as much as possible from the group, as well as *to facilitate* the conversations and discussions within the group (hopes & fears, stakeholder analysis, resource inventory, data estimates, projections and scenarios)

Interpretive dialogue (analysis and discussion)

In this section, we transcribe the dialogue for Record number 2 to follow up on the illustration of the findings initiated in the previous section. The dialogue contains four parts:

1. First, the Moderator introduces the characters and their roles, and lays out the rules of the discussion;
2. In the second part, the Moderator introduces the Record (event) that will be discussed;
3. In the third part, the panelists (Ms. MW and Mr. BO) describe the substance of the record, and analyze the document (in this case also an event) using their individual lenses. This is where the micro-world vs. boundary-object argumentation takes place;
4. Finally, in the last part, the Moderator and the Participant summarize tension points and propose syntheses to the arguments.

We chose to illustrate the method using this record because it addresses what happened in an actual client-group meeting.[14]

[14] Appendix 7 contains the dialogue for Record number 1, the project proposal. The reader may find it useful to read this Appendix after the first part, i.e., after the Moderator describes the rules of the discussion, but before the discussion of Record 2 (in Parts 2, 3 and 4).

– The Dialogue –

Part 1 – Rules of the discussion

Moderator – Before we begin our discussion, allow me to explain to the audience what we are doing here, and some of the rules of our debate:

We are here to examine some documents pertaining to a GMB intervention carried out by a modeling team from the University at Albany. This team worked with several client groups in a project that examined issues related to welfare reform (see Rogers *et al.* 1997, Allers *et al.* 1998, Rohrbaugh 2000, Zagonel 2003, Zagonel *et al.* 2004). This project took place in 1997 and 1998. The discussion will be centered upon issues related to problem identification and definition, and model conceptualization in system dynamics, as applied in this GMB project.

We'll draw upon two frameworks to base this discussion. The first framework, denominated "best practices" (Martínez-Moyano and Richardson 2002), will help us distinguish problem identification and definition from model conceptualization issues, and will provide us with some structure for a survey of the material along the lines of accepted SD practice.

The second framework is more important for the purpose of our discussion because it will help us distinguish two possibly competing aims involved in group model building. Ideally, as Eden (1990) appropriately pointed out, "astute analysis" (insight) and "skillful facilitation" (consensus building) should be combined: "within the context of group decision support it may be suggested that the two skills can become integrally tied together so that they are fully interdependent" (p. 49). While this may be an ideal, Zagonel (2002) suggested that there are tensions related to bringing these two skills together:

> The objectives and procedures for using the model building process as a tool for creating shared understanding of an interpersonal or inter-organizational problem –in the form of a "boundary-object" model, and as a tool for exploring a "micro-world" representation of reality –to address this particular problem, are not necessarily aligned. While GMB interventions are designed to achieve this ideal goal by intertwining these two threads, in reality, one or both may be sacrificed.

I, as the **Moderator**, will introduce and facilitate the discussion of each of the documents we will be examining. I will also summarize the panel's findings and highlight contentions. I will act as a neutral voice in this debate.

I will be facilitating a debate between two points of view on the aim of GMB interventions, based upon the conceptual distinctions specified above. **Ms. Micro World** will take the side of the pursuit of insight, and **Mr. Boundary Object** will take the side of the pursuit of consensus. These two system dynamicists have been instructed to stick

to their roles, and to see the evidence in light of the aim of group model building assigned to them. Their job is to accentuate the conceptual distinction, finding empirical evidence for their positions in the documentation, and making the distinction as vivid as possible.

One other actor will take part in this debate. This actor was a member of the modeling team in this intervention and will be able to give us a participant's perspective. The **Participant** is the reason why we are here today. He is interested in empirically substantiating these juxtaposing views (of micro worlds vs. boundary objects), and pushing this debate in the direction of some constructive criticism aimed at improving GMB theory and practice. The **Participant** developed the second framework, in light of his experience in this project, and based upon a survey of the GMB literature, tracing it to its roots in system dynamics and decision conferencing (Zagonel, 2002). The **Participant** will provide us with information that may not be available in the documentation, and clarifications. Finally, he and I will attempt to bring some degree of synthesis, resolution and closure to the two points of view presented by **Ms. MW** and **Mr. BO**.

The purpose of this debate, then, is to highlight these two (arguably distinct) aims of group model building, to weigh their presence in this particular case, to assess points of tension between them, and to suggest improvements to be made in the approach adopted by the Albany school. We realize the limitations of generalizing from this portion of one case, to all of the practice done by the Albany modeling team, but we have faith that our reflection here will be of some use to them. We also think that a lively description of this case will provide a rich understanding of group model building to interested audiences, specifically of this particular approach.

Part 2 – Introduction and context

Moderator – Let's move on to the first actual meeting of this intervention, the issue elicitation meeting on February 11, 1997 in Cortland County (R-02). This meeting had eleven local participants (the commissioner of the local Department of Social Services with five of her aids, plus five representatives of other local organizations, public and nonprofit, executive and legislative), and three State observers. The modeling team was represented by three members, two alternating in the roles of facilitator and process coach, and one as recorder.

I'll begin by summarizing the result of our panel's analysis on the "best practices" content of this document:

As synthesized in Table 5, our panel has found evidence in this document related to eight out of the thirteen highest-rated best practices (#1-problem, #2-purpose, #3-dynamics, #4-causal stories, #6-prior experience, #8-creativity and flexibility, #9-conceptual building blocks, and #10-key stocks).

Issues of interest were elicited using a hopes-and-fears exercise. The facilitator clustered the participants' ideas and extracted a number of themes, such as managing change, promoting integration of services and client responsibility, concern with ineligibility and inability to provide services to people with special needs, inadequacy of resources, and conflicting organizational missions across service providers (i).

The county commissioner laid out the purpose of the intervention as evaluating the impact of implementing policy options under consideration (ii). The facilitator promised to draw upon the participants themselves to capture the issues of interest to them, and to reveal the interrelations within the welfare system. Modeling and simulation was offered as a tool to enable the participants to gain experience with how the system worked as a whole (iii). In addition to problem issues, a number of goals transpired from the hopes-and-fears exercise, such as to develop a strategy to move clients to work, to develop community-wide approaches to serve clients in need, to avoid an increase in the local tax burden, to assess resource needs, among others (iv).

In addition to the hopes-and-fears exercise, it is worth noting that the facilitator used three other idiosyncratic scripts during the day:[15]

xii. A stakeholder analysis, of both internal and external population groups and organizations (pp. 6 and 7);
xiii. A resource-inventory exercise (p. 8), and
xiv. A judgment approach using nominal-group exercises to estimate the value of stocks and inflows (pp. 10, 14 and 17)

The results of the stakeholder analysis and of the resource inventory helped to generate the list of client groups and resources stocks. Almost two-dozen accumulations were identified (xi). These stocks, as well as their inflows, were quantified using social judgment estimation (viii).

Finally:

xv. A list of policy options was generated with the client group, including an "employability assessment and placement policy", and a "no one will freeze or starve policy."

In the context of thinking through the implementation of these two policies, reference modes were drawn to explore the participants' expectations of future patterns of behavior of four stocks, two resources (employment/training dollars, and emergency service capacity), and two client populations (single-parents unemployed less-than-one-year, and unemployed over-one-year) (v and x). The expected/projected dynamics were explained in terms of causal stories (vi).

Part 3 – Thesis and antithesis

Moderator – Let's begin the discussion with Mr. BO's point of view. Please refer to Tables 5 and 6 as you make your argument.

[15] These items were also recorded with Roman numerals, sandwiched in the sequence of the numbers used in the "best practices" and "dichotomy" detailed coding-sheets. The page numbers refer to the pages in the record where the information is found.

Mr. BO – I found in this document quite a bit of evidence of "boundary-object" model building. I'd like to begin with the issue of problem identification and definition, and to comment on how ***two aspects of this intervention relate to and feed upon each other, the diverse client base and the messy nature of the problem***.

As already noted by our Moderator, this meeting had a total of 14 client participants, and they were a fairly heterogeneous group, representing social services, health, mental health, labor, managed care, a nonprofit, and the legislature (xxii). According to this document, they had broad views on the issues and on the purpose of the intervention. These different perspectives were welcomed and respected. No *one* specific issue or goal was embraced as the *key* problem or purpose to address in the intervention (xxiii). Instead, a number of issues were raised (regarding the challenge of change, and how it would impact the local tax base, clients, providers and employees; whether federal mandates and requirements could be met, such as successfully placing clients in jobs and helping them attain self sufficiency). The hopes-and-fears exercise did not produce consensus on what the main problem was (whether to manage the transition, integrate services, strengthen families or become more cost-effective) (xvii).

Also, several purposes were associated with the intervention. As stated by the commissioner, to evaluate the impact of the Department's policy implementation decisions; by the facilitator, to draw upon the group to capture the spectrum of issues and interrelations in the system, and to improve the participants' understanding regarding how the system works; but also, to address a number of issues and uncertainties, and to delineate the participants' goals and objectives, to promote cooperation, and to achieve some degree of consensus and commitment in policy implementation (xvi and xx). More stakeholders (actors and organizations) were identified as associated with the goals and issues specified for the intervention, to enrich viewpoints and possibly enlarge participation (xxiv). Thus, ***the diversity in the client base produced many interests and interpretations regarding the nature of the problem, and the broader view of the scope of the problem served also to enlarge the knowledge base needed, as well as the constituencies affected, in reinforcing ways***.

Nevertheless, some closure was achieved by choosing to concentrate the modeling effort upon the TANF program (or system), and Cortland's vision for its implementation (holistic assessment and placement, integrated client database, confidentiality and information sharing among providers, monitoring for results, etc.) (xviii). Therefore, ***in my view, the emphasis of the intervention became consensus building. The desire to align inter-organizational missions, goals, objectives and strategies in the implementation of TANF is implicit in the discussion. Also, the facilitator explicitly stated that group model building would help achieve some degree of consensus within the group*** (xxi).

Ms. MW – But this is not the kind of closure one needs in order to build a model. It is not good SD practice to build a model of a system. A clear problem statement, depicted in reference modes of behavior, should guide model conceptualization. Also, a dynamic hypothesis is needed that explains the problematic behaviors.

As argued by Sterman (2000, pp. 94-95):

> Once the problem has been identified and characterized over an appropriate time horizon, modelers must begin to develop a theory, called a *dynamic hypothesis*, to account for the problematic behavior… A dynamic hypothesis is a working theory of how the problem arose… Much of the remainder of the modeling process helps you to test the dynamic hypothesis…

It is my reading of this document that the problem has neither been identified nor characterized. The modeling team went into too much detail, and lost sight of the forest for the trees. For example, while too many stocks were identified (total 23), ***no "historical" reference modes were drawn***. As noted by our Moderator, the reference modes that were drawn focused upon (local) policy (or strategy) implementation, as opposed to historic problematic behaviors. Even if the problem was to unfold in the future, as a result of (federal) welfare reform, ***anticipated "problematic" behaviors were not projected***. For example, graphs could have been drawn for "loss of TANF eligibility" due to timing out, or for the impact on the local tax base resulting from (federal) reform.

I think the modelers would have done well for themselves if they had focused on a smaller number of key stocks, and drawn more reference modes for those key variables. Also, they might have tried to capture the causal stories told for the dynamic behaviors in causal-loop diagrams, gradually evolving to a synthesis in problem definition, in the form of a dynamic hypothesis, to account for (graphically depicted) problematic behaviors.

In my opinion, the problem has not yet been identified. Indeed, this intervention seems to be moving in the direction of modeling the system, which is a questionable practice. ***So far, this model building effort lacks a "problem" focus***.

Mr. BO – I disagree. What you regard as poor practice may be regarded by others as good practice, and a necessary approach due to the nature of the problem. I'll explain…

There are reasons that justify the lack of synthesis in problem definition, and the non-intrusive nature of the approach used by the facilitator. First, ***the lack of synthesis is a reflection of the messy nature of the problem***. In order to get at the "real" issues of concern to the participants, and reveal their (hidden) agendas, ***a wealth of information was obtained using "divergent" scripts***, which encouraged the client group to discuss issues freely from different angles (hopes and fears, stakeholder analysis, resource inventory, policy options, projections and scenarios) (xxvii).

Second, ***the facilitator may have avoided, at this early stage of the intervention, to bring premature closure to the direction of the modeling effort, or to restrain the discussion imposing "convergent" scripts drawn from the SD framework***. This would explain the absence of causal-loop diagrams, stock-and-flow structures and, especially, of

dynamic hypotheses. Note that the only SD tool introduced in this first meeting was drawing dynamics of some variables, including assessing their appropriate time frames (xxviii).

Therefore, instead of narrowing down problem definition, or even purpose, those were defined very broadly. But a wealth of information was shared in this meeting: several visions, goals and objectives were discussed, as well as issues of concern; and stakeholders associated with these goals and issues were listed in order to assess the need to expand the group of participants (xxv). ***The SD method was not made a major focus of this first meeting***. Although key variables were identified, their units defined, and their ongoing values estimated, the behavior of variables was discussed only in terms of short stories, without any attempt to close in on the structures giving shape to those behaviors (xxvi).

All of this is well and good in this stage of the intervention and given the nature of the problem. In fact, ***at this point, I would be primarily concerned with asking myself whether system dynamics is the best framework to be used in this intervention*** (xxviii). Therefore, if I were facilitating this meeting, I would not be abusing its use until I was confident that this was the way to go.

Moderator – Ms. MW, you've stated that you're not satisfied with the results of this approach, but are there aspects of this day that you did like?

Ms. MW – Yes. I liked the fact that the facilitator stated that modeling and simulation would help clarify and test the participants' views and assumptions about system-wide relationships and behaviors (xix). In other words, that ***the intervention was explained as an opportunity to put the participants' views and opinions through a test, thus deriving more objective knowledge*** (xxix). I also want to highlight how ***bringing in an outside perspective, introducing graphs of behavior over time, helped to add rigor to the discussion, reveal differences of opinion among the participants, as well as discover areas of ignorance and uncertainty*** (xxxiv). It's obvious to me that the participants didn't really know what was going to happen when welfare reform was implemented. They may have an idea about the structures that shape behavior, but they certainly cannot mentally simulate their implications.

Part 4 – Synthesis

Moderator – Table 6 portrays a clear bias in favor of the boundary-object approach in this meeting. Ms. MW objected and made several suggestions to even the balance. Mr. BO argued the approach used was justifiable. ***I would like to attempt to summarize these differences in opinion around three tension points that I could pick up from the panel's discussion***. Then I'll ask the Participant to give us his view on this group modeling meeting.

The first point of tension has to do with the facilitator's (or modeling team's) willingness to use "intrusive" framing in the process of issue elicitation and problem

definition. I think this reflects a personal preference based on individual values, beliefs and style. ***At the core of this dilemma is the facilitator's view of how to go about helping the clients.*** Is the facilitator an expert that will help identify the clients' problem and find a solution? Or, is s/he there to simply help the clients engage in a discovery process? ***Does the modeling team think they will provide the answer to the clients, or that the clients will find the answer for themselves?***

The first approach draws upon framing and analytical tools that help direct the group's discussion, provide focus, contrast views, examine issues in more depth, and test assumptions. But they have the draw back of acting as filters of knowledge. The second approach avoids such framing and filtering, pursues breadth, and allows the participants themselves to direct the conversation. But without using these analytical tools, the benefits of system dynamics are lost or severely undermined. Many of the tools available in system dynamics require convergence (focusing on key stocks, agreeing upon reference modes and causal structures, graphically depicting problematic behaviors, and deriving a dynamic hypothesis); while, early on in the intervention divergence is needed to avoid premature closure on the wrong (or less important) problems. So, timing is also a critical issue. Therefore, there is a tradeoff between avoiding premature closure and not going deep enough in the analysis. To the extent that the framework is used, added rigor is exercised in the elicitation, discussion and analysis.

The second point of tension is related to the nature of the problem and/or client group. A very diverse stakeholder group with differences of opinion and/or dealing with a messy problem will present resistance to synthesis in problem definition. The facilitator who tries to impose synthesis may be faced with hostility from minority group members. Apathy may also result from premature closure on problems that do not capture the groups' interest and attention; some participants may perceive the problem as unimportant or irrelevant. Even though eventually the deeper issues might surface in the modeling effort, in the process, alienation and lack of trust may have already set in the group, undermining the intervention. Therefore, ***an assessment of the nature of the problem and client group is needed***. Consequently, ***in some situations it will be easier than others to pursue synthesis***.

A final point of tension is symptomatic of how the previous two points are resolved. It has to do with the modeling effort being "problem" or "system" focused. A problem-focused intervention will draw more directly upon core system dynamics, including problem definition synthesized in the form of a dynamic hypothesis. A system-focused intervention is "safer" because it delays the use of convergent scripts, reduces the risk of premature closure, and allows for more detail (diversity) to be incorporated in the conceptual model. This delay allows for rapport to be built within the group, and also between the group and the facilitator. This rapport is later drawn upon in convergent exercises aimed at building group consensus.

Participant, in your view, did this meeting strike a proper balance between the micro-world and boundary-object perspectives? To what do you attribute the bias we observed in favor of the latter?

Participant – No, I don't think it did. I think Ms. MW is correct when she argues that the problem has not been sufficiently identified nor characterized. ***I think the main reason for the bias we observed is the absence of a modeler playing the role of reflector during this meeting***. Normally the reflector would be responsible for making the intervention adhere to the SD method (focusing on the problem, drawing problematic reference modes, examining causal structures, and crafting dynamic hypotheses linking behavior to structure).

The fact is we were not adequately prepared to hold this meeting. Background information available to the project champion had not been shared with the modeling team. Specific issues of concern had not been brainstormed nor considered. The schedule of the day and the scripts to be used had not been thought out in advance. The reflector could not be there. All of these aspects are important to strike the proper balance in "intrusiveness" using the SD framework.

Andersen and Richardson (1997) argue that the key to successful group model building "is selecting the most appropriate type of group structure and group task for each point in time in the modeling conference" (p. 111). These exercises are developed into scripts -"sophisticated pieces of small group process" (p. 107)- "planned and rehearsed for accomplishing sub goals in the course of a group model building workshop" (Richardson and Andersen 1995, p. 130). Without these scripts, and without the two modelers playing complementary (and sometimes competing) roles, it is difficult to strike the proper balance between facilitation vs. reflection, divergent vs. convergent thinking, focus on process vs. content, consensus building vs. insight, to name a few of the tensions.

The facilitator did a good job given the circumstances, but ***the tension was poorly handled simply because no one was focusing on the role of reflector, and careful consideration had not been given to how to carry out the day***. I think the three points of tension identified by the Moderator are important. But, I prefer to address them later, as the panel covers more material from the meetings. I suspect a more even balance will be observed in future meetings, especially those in which a reflector is present.

Diagrammatic displays (research findings and analysis)

As previously stated, the process of coding, and particularly of completing the detailed coding-sheets, was very time consuming. Writing up the dialogues, as illustrated in the previous section was even more cumbersome. The dialogue regarding Record 2 is nearly 3,000 words (10 double-spaced pages) in length (Parts 2, 3 and 4). We estimate this task demanded approximately ten hours. Therefore, the whole exercise of coding, recording, analyzing and writing up this one record –17 pages in length– took approximately 17 hours. This rough estimate suggests that this approach to identifying and characterizing the tensions in group model building expends about one hour per page of the archives. If we were to proceed and write up the dialogue for all seven records (containing 92 pages),

the exercise would take us somewhere in the neighborhood of 100 hours, and the dialogue would add up to approximately 15,000 words (50 double-spaced pages).[16]

Also, the results –presented in the form of "detailed" coding-sheets, and the discussion –in the form of the dialectic, constitute an overwhelming amount of information for the reader to digest. Furthermore, the temptation to write interpretive dialogues that border the Straw Men fallacy, coupled with the easiness of becoming increasingly repetitive, urge us to investigate alternative solutions (more efficient, faster) to organize, report and illustrate the results of the effort to identify and characterize tensions in GMB applications.

In this section we discuss how we adapted the Competing Values Approach (CVA) framework, and generated diagrammatic displays that may serve as efficient and useful illustrations of the results of examining and coding the documents. Of course, these diagrammatic displays can also be used as complements, rather than substitutes of the interpretive dialogues. In addition to pursuing efficiency, we regard this effort also as a natural development toward quantification of the qualitative findings presented thus far, i.e., toward measuring the outcomes resulting from the interplay of the tensions.

This section is divided into three parts: First, we briefly illustrate the CVA framework and discuss the proposed adaptation. Second, we show how we proceeded toward quantification of findings. Third, we illustrate the results with graphical displays/diagrams. We provide three illustrations: one for a single record, and two comparative displays.

ADAPTATION OF THE CVA FRAMEWORK.[17] Zagonel (2002) provided an overview of this framework. Here, we highlight the four competing perspectives that the authors propose

[16] These numbers probably overestimate the effort, given that there would be reoccurring issues that need not be readdressed for every record. Also, records could be grouped before writing up the dialogue. For example, we could group Records 3-6 and write them up in a single dialogue, all related to modeling-team preparation for the model conceptualization meetings. Differences found in the relative content of these records could actually become part of the discussion. In any case, to extrapolate our projections to the entire archives, the level of effort needed to code, record, analyze and write-up in the form of interpretive dialogues the entire project, could be as much as 1,000 hours, and the dialogue could add up to approximately 150,000 words (500 double-spaced pages). This is assuming that this sample constitutes 10 percent of the full archives. This estimate does not account for the additional cognitive difficulty related to coding for all steps of the modeling method (formulation and simulation, model testing and evaluation, etc.).

[17] The diagrammatic displays contained in this research were adapted from the multidimensional scaling work of Quinn and Rohrbaugh (1983). We use a similar spatial display to depict quantitatively the results of our qualitative coding and recording. We find the geometry of this type of display more useful than any other (e.g., bar charts). However, they may be misleading, particularly to those familiar with the Competing Values Approach (CVA) framework. While the axes of the CVA framework, and their relative dispositions, were uncovered empirically using factor extraction method of analysis, the axes of our diagrammatic displays were hypothesized

to balance: political, rational, empirical and consensual. In their article, Quinn *et al.* (1985) use the CVA framework to characterize a dichotomy between management science and organizational development. There is an obvious parallel between the dichotomy they discuss, and the one that we describe in our research. The micro-world approach to model building and use is to system dynamics what the management science approach is to decision making. They draw heavily upon the rational and empirical perspectives. On the other hand, the boundary-object approach is to system dynamics what the organizational development approach is to decision making. They draw heavily, instead, upon the political and consensual perspectives.

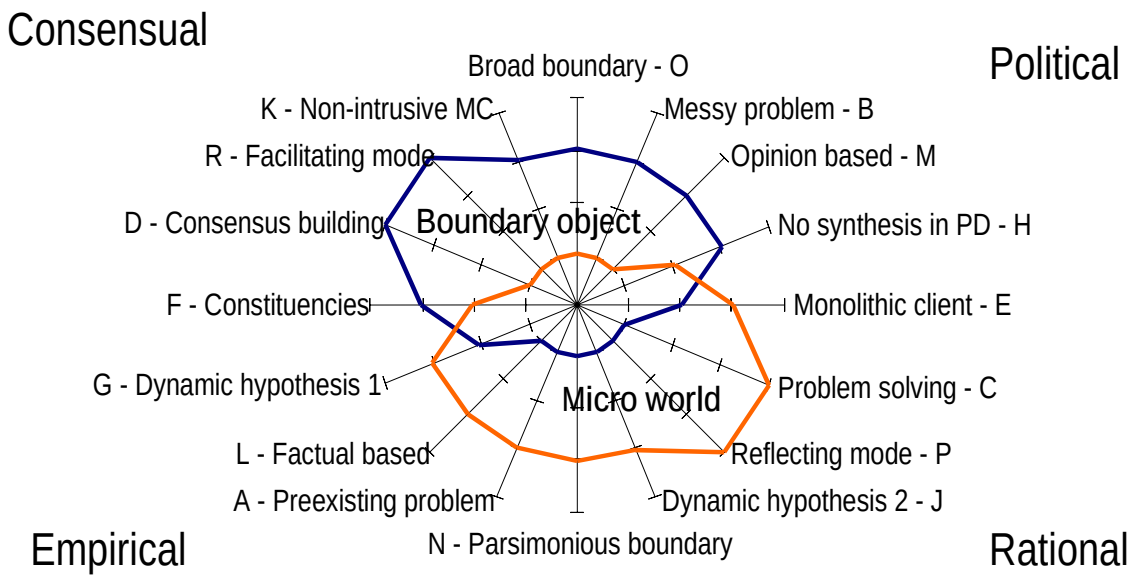
Our "intuitive" adaptation of this framework takes two things into account: First, each of the tension points we identified in group model building represents an axis with two polar forces at the extremes. Second, the criteria for effectiveness in any given quadrant "tend to complement somewhat the criteria in neighboring quadrants" but "stand in sharp contrast to criteria in the opposite quadrant (*Ibid.*, pp. 50). Based upon these two premises, we layered the eight tension points and sixteen polar forces into this two-dimensional space, in the manner illustrated in Figure 1.

In our adaptation of this framework, the tensions between the *political* and *empirical* domains are depicted in the following manner:

Polar forces in the ***Political*** domain:	Tension points (axes):	Polar forces in the ***Empirical*** domain:
Messy problem	Nature or context of the ***problem***	***Preexisting*** problem
Conceptualization based upon ***views and opinions***	***Objectiveness*** of the information used	Conceptualization based upon ***theory and facts***
No synthesis is attempted	Form of ***synthesis*** in problem definition	***Dynamic hypothesis 1***

from the literature review, and have not been empirically tested. Furthermore, while the dimensions in the CVA framework are multiple and orthogonal, describing a multidimensional space, our diagrammatic displays are only two-dimensional. Finally, while our diagrams are nicely drawn in symmetrical fashion and containing equally spaced axes, we hold no claim that this is the way it is, or should be.

Figure 1 – Adapted CVA graphical representation



Therefore, we assume:

- *Political* issues are not easily synthesized; they are based upon competing views and opinions; they characterize a messy situation or problem.

- *Empirical* issues are more clearly defined in the form of hypotheses; they are based upon established theory and factual information; they characterize an agreed-upon (preexisting) problem.

We note that the tensions between the political and empirical domains entail two tension points (or axis) around problem identification and definition (shaded) –the nature of the problem and the form of synthesis, and one around model conceptualization –the objectiveness of the information.

The tensions between the *rational* and *consensual* domains are depicted in the following manner:

Polar forces in the ***Rational*** domain:	Tension points (axes):	Polar forces in the ***Consensual*** domain:
Problem solving	***Purpose*** of the modeling effort	***Consensus building***
Modeler acts as a ***reflector*** or expert	***Role of the modeler***	Modeler acts as a process ***facilitator***
Dynamic hypothesis 2	***Intrusiveness*** of the framework	***Non-intrusive*** approach to conceptualization

Therefore, we assume:

- *Rational* approaches are based upon problem solving; they emphasize deduction; they require analysis and reflection.

- *Consensual* approaches are based upon consensus building; they emphasize induction; they require process facilitation.

We note that the tensions between the rational and empirical domains entail one tension point (or axis) around problem identification and definition (shaded) –the purpose of the modeling effort, and two around model conceptualization –the intrusiveness of the framework and the role of the modeler.

Finally, we note that two tension points (or axes) fall at the border of quadrants, rather than within quadrants:

Border of ***Political/Rational***:	Tension points (axes):	Border of ***Empirical/Consensual***:
Monolithic (or single) client	Type of ***client/audience***	***Constituencies***, stakeholders

Border of ***Rational/Empirical***:	Tension points (axes):	Border of ***Political/Consensual***:
Parsimonious and guided by dynamic hypothesis	Definition of ***model boundary***	***Broad*** resulting from ***negotiation process***

The fourth and final tension point around problem identification and definition –the type of client/audience (shaded), divides the Southern from the Northern hemispheres:

- A monolithic (or single) client point-of-view characterizes a political or rational perspective on the problem, depending if the issue is a power struggle or an analytical exercise, respectively.

- A constituency (or stakeholder) audience point-of-view characterizes an empirical or consensual approach to the problem, depending if empirical evidence or democratic processes, respectively are used to create coalitions.

Finally, the fourth and final tension point around model conceptualization –the definition of the model boundary, divides the Eastern from the Western hemispheres:

- A broad boundary defined through a negotiation process characterizes a political or consensual perspective on the problem, depending if a power struggle or a democratic process, respectively, is used to define the boundary.

– A parsimonious boundary guided by a dynamic hypothesis characterizes an empirical or rational perspective on the problem, depending if empirical evidence or rational processes, respectively, are used to find solutions to the problem.

Provided that this adaptation of the CVA framework makes sense, we still need to quantify the observations captured in the detailed coding-sheets. This step is illustrated in the next subsection.

SUMMARY STATISTICS FOR DICHOTOMY CONTENT. We produced summary statistics by counting the number of pieces of evidence ("chunks of information") observed in the record, for each category of code ("buckets"). The results for the issue elicitation meeting are displayed in Table 7.

Table 7. Summary statistics for dichotomy content
(Record 2: Issue elicitation meeting – February 11, 1997)

Problem identification and definition:	Micro-world perspective:	Boundary-object perspective:	Subtotal (number of pieces of evidence)
Problem	A – Preexisting 0	B – Messy 3	3
Purpose	C – Problem solving 1	D – Consensus building 2	3
Client/audience	E – Monolithic 0	F – Constituencies 3	3
Synthesis	G – Dynamic hypothesis 1 0	H – None 2	2
Subtotal (number of pieces of evidence)	1	10	11
Model conceptualization:	Micro-world perspective:	Boundary-object perspective:	Subtotal (number of pieces of evidence)
Intrusiveness	J – Dynamic hypothesis 2 0	K – Non-intrusive 2	2
Objectiveness	L – Theories/facts 1	M – Views/opinions 2	3
Boundary	N – Guided/parsimonious 0	O – Negotiated/broad 2	2
Role of the modeler	P – Reflector 2	R – Facilitator 2	4
Subtotal (number of pieces of evidence)	3	8	11
Overall total:	4	18	22

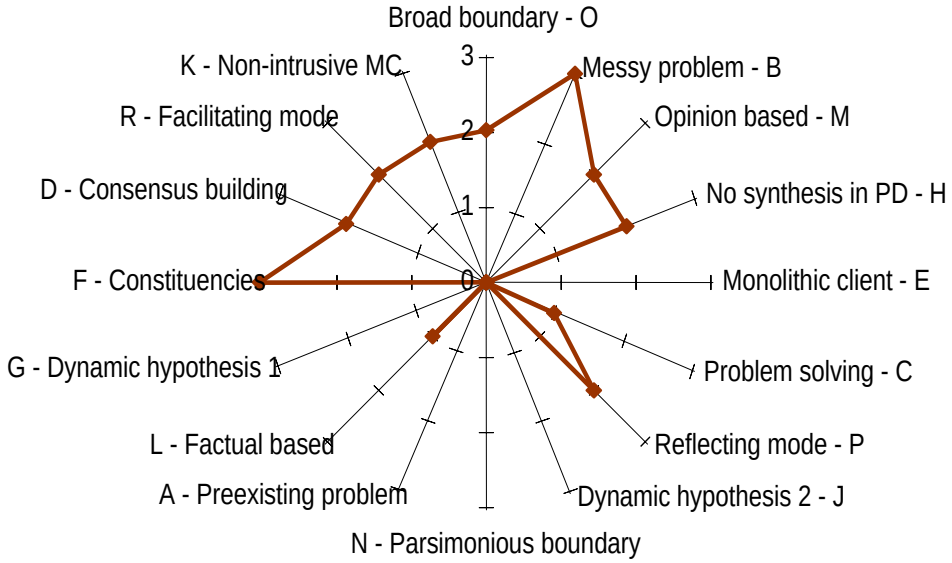
In this table, we shaded the cells ("buckets") containing at least one piece of evidence ("chunk"). This format for displaying the results also indicates the bias toward boundary

object. There are eighteen pieces of evidence supporting the boundary-object perspective, and only four for the micro-world perspective. Some of the categories of code for the micro-world perspective are empty: There is no evidence of a preexisting problem, monolithic client, use of dynamic hypotheses, or parsimonious/guided boundary definition. In contrast, all of the categories of code for the boundary-object perspective contain two or three pieces of evidence. The evidence is evenly distributed between the problem identification and definition, and the model conceptualization steps. This is a bit odd since the purpose of this meeting was mainly to address problem identification and definition.

Summary statistics were also compiled for the other records. In the next subsection we illustrate with graphical representations the spaces occupied in the adapted CVA map for Records 1 and 2.

SINGLE AND COMPARATIVE GRAPHICAL REPRESENTATIONS. Figure 2 contains the diagrammatic display for the issue elicitation meeting (Record 2).

Figure 2 – Diagrammatic display of dichotomy content
(Record 2: Issue elicitation meeting – February 11, 1997)



It is interesting to observe the spaces occupied in each of the four quadrants, and specifically, the difference in occupation of the Northern vs. Southern hemispheres. The issue elicitation meeting is clearly more "boundary-object" oriented (the "amoeba" is predominantly in the northern hemisphere of the graph). The graphical representation helps to identify gaps in the intervention. The Empirical perspective is, presumably, the most neglected in this client meeting. There was only one piece of evidence reinforcing an empirical concern: "The intervention was explained as an opportunity to put views and opinions through a *test* (Zagonel *et al.* 1997, p. 13), thus deriving more objective knowledge" (item xxix).

If these results could be made available quickly, conceivably, one could chart the course of the intervention to cover an area that has been neglected or underemphasized. In this case, for example, the modeling team could place a request for hard data to substantiate reference modes drawn by hand (among many other measures that could be taken). GMB scripts could be categorized in this manner, and the facilitator could pull out from a list of scripts those that address the area neglected, choosing among them the one that appears appropriate.

Figures 3 and 4 portray the comparison between two records. In Figure 3, the issue elicitation meeting is contrasted with the project proposal. In Figure 4, the issue elicitation meeting is contrasted with the concept-model meetings.

Figure 3 – Comparative diagrammatic displays of dichotomy content
(Records 1 and 2: Proposal vs. Issue elicitation meeting)

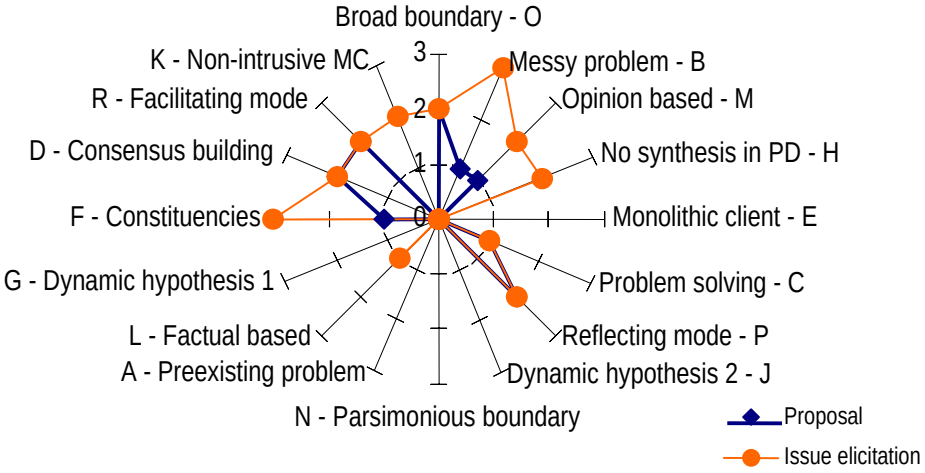
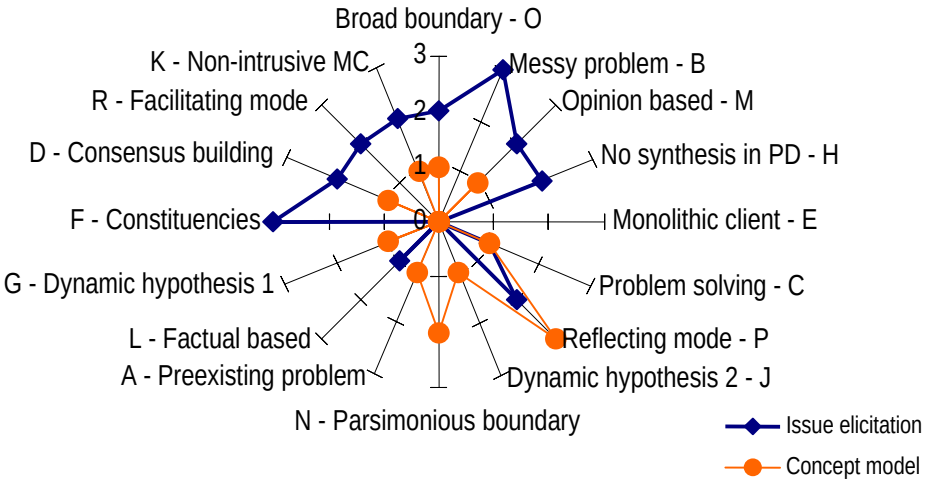


Figure 4 – Comparative diagrammatic displays of dichotomy content
(Records 2 and 6: Issue elicitation meeting vs. Concept model meetings)



In these comparative graphs, it is interesting to observe the "relative" sizes and positions occupied by the "amoebas". The proposal covers a much smaller area than the issue elicitation meeting. On the other hand, the concept model meeting is located further south (less boundary-object and more micro-world oriented).

Summary and discussion

We conducted this pilot study to develop new instruments and procedures aimed at identifying and characterizing tensions in group model building associated with two competing approaches: modeling as a representation of reality –models as *micro-words*, and modeling as a tool for negotiating a social order –models as *boundary objects*.

This study was based upon the following premises: First, the tensions we speak of exist for every step of the modeling process, and they result from the dual goals of pursuing individual insight (*learning*), and group *consensus*, respectively –two different objectives that are not necessarily aligned with each other, but that are both necessary conditions for achieving sustainable organizational change. Second, we assumed that effective group model building requires integrating and balancing these two goals to achieve "consensual learning", commonly referred to as *team learning*.

We set out to investigate the first two steps of the SD method: problem identification and definition, and model conceptualization. We built upon a conceptual framework –based upon a review of the literature– that identified eight tension points, and sixteen polar forces. We used a select group of documents from the archives of one large-scale GMB project as an empirical basis for experimentation with these instruments and procedures.

The objective was to create an interpretive dialogue that would help understand the competing values in these two approaches. Specifically, the dialogue should help:

- Bring each perspective to life and provide illustrations of the tensions and polar forces;
- Provide guidance to develop theory aimed at improving the balance of these two approaches; and
- Direct the development of principles and heuristics for skillfully intertwining them in practice.

In order to create this dialogue, we first developed the following instruments:

1. A concise and clear conceptual framework in the form of an ideal-type dichotomy, identifying tension points and polar forces (in this study for problem identification and definition, and model conceptualization only);
2. Detailed coding rules for identifying the constructs used in the conceptual framework;

3. Summary and detailed coding-sheets for capturing the results of coding and recording;
4. A role-playing script involving four characters: a Moderator (neutral voice), two "caricatured" panelists (representing each side of the ideal-type dichotomy), and the Participant in the intervention (the author);
5. A dialectic form of analysis consisting of having the panelists present and argue thesis and antithesis, followed by an attempt at synthesis by the author.

We found this preliminary effort to be useful, even at a pilot scale, for the following reasons:

- It enriched the theoretical argument presented in Zagonel (2002);
- It tied theory to specific instances and practices;
- It contained a number of research products (tension points, polar forces, coding rules, coding sheets, interpretive dialogues, and diagrammatic displays). These research products, and the procedures used to apply them were effective, and clarified and distinguished the two approaches in practice, making them concrete, and vividly clear;
- It was successful in telling two rich and convincing stories on model conceptualization, one for each side of the argument;
- It can be replicated.

In sum, it helped create "objective" knowledge, through theory development, tied to observation and measurement of tensions. Thus, it contributed to the effort to move the field from craft to science.

Also, this study shifts focus toward theoretical and practical issues that have generally been treated only implicitly in GMB literature:

- How do we choose an appropriate modeling approach or framework to use in building a model with a client group?
- When should modelers be pure facilitators, and when should they be social scientists that bring in their perspectives and concepts to bear on the group's problems?

The theoretical argument and the preliminary results of this pilot study suggest that both questions need to be *explicitly* addressed and answered. Moreover, it is not adequate to choose an approach, or behave in ways that simply reflect our own methodological and personal biases as modelers and facilitators. The modeling approach, the roles of the modelers, and their relative influences should address the nature of the problem, the context of the situation, and the specific needs of the client group, rather than the personal preferences –based upon individual values, beliefs and styles– or methodological skills of the modeling-team members.

Rohrbaugh and Eden (1990) propose the need to match the client's setting (and needs) with the consultant's style and method (pp. 45-47). We go further, to propose that

facilitators and modelers need to "know thy selves", and to be able to work beyond their natural abilities, developing areas of individual weaknesses in order to serve the client group with the appropriate framework and attitude, given the nature of the problem and context of the situation. The concept of "teamwork" (Richardson and Andersen 1995) is more than dividing conflicting roles. It is also outfitting modeling-team members with a diversity of needed skills, and adequately balancing their relative influences during the intervention.

The findings also suggest that group model building may be (naturally) biased toward the boundary-object approach. At least, this is evident in this small sample of documents. This was observed in the coding sheets, both in the absence of several of the best practices, as well as in the unevenness between the two sides of the dichotomy. This was also highlighted in the dialogue. In order to even out the balance, GMB theory and practice should propose principles and heuristics for:

- Adjusting the influence of the facilitator *vis-à-vis* the reflector, and suggesting guidelines for when it is appropriate (and desirable) that the reflector "hold the floor";

- Give explicit treatment to the issues of problem synthesis, and intrusiveness of the modeling framework, and suggesting guidelines for when it is appropriate (and desirable) to transition from divergent to convergent problem definition and conceptualization scripts and approaches. Specifically, the field needs to reconcile its modeling approaches (Richardson and Andersen 1995, Vennix 1996, Andersen and Richardson 1997) with core SD modeling practice (Sterman 2000). In particular, it needs to provide adequate space and treatment to the concept of the "dynamic hypothesis", and its role in the GMB approach to SD modeling;

- Reconciling the acceptance of "concepts in use" (including social judgments) from the domain experts, with "reality checks" that systematically contrast the views and opinions of the client team with robust theory and hard empirical evidence. Reality checks can take many forms, including contrasting model results with a reality "external" to the group. This should include, but not be limited to, finding a good fit in model behaviors with observed historically based reference modes (e.g., Zagonel 2003).

Understanding focal points and polar forces, and the different elements and techniques of both approaches is crucial for a proper integration of these elements at the right place, time and situation, and for the right objective, hence improving group model building. Within the limitations of this pilot study, we began to examine the question of when in an intervention, which elements help shape the results in which ways. These tensions need not necessarily be opposites. They may as well be complements. The tension only arises if the elements are not properly applied. Group model building can only move from craft to science if these tensions can be successfully identified and resolved.

Limitations[18] and future research

This pilot study should *not* be interpreted as an attempt to test theory related to these tensions. It also was *not* an empirical assessment to provide evidence in favor of, or to refute the existence of micro-world or boundary-object approaches to model building and use. It certainly was *not* an argument that these "ideal" types actually exist. These were *not* the intended results of this phase of this research. Besides, the empirical base used in this paper did *not* suit itself for these objectives. Here, we examined only the first handful of documents belonging to one case. Thus, we made *no* claim that the findings are representative of the case, or that they may be generalized to GMB practice, in Albany or elsewhere. The procedures and instruments developed thus far are insipient and have been observed to present low reliability. Finally, the framework and the instruments developed thus far rest only upon theoretical considerations, and lack empirical foundation to assure their validity.

While apparently effective, the instruments and procedures developed and used in this pilot study were very time intensive and, thus, inefficient. The amount of time required to examine a representative sample for the population of GMB interventions (using these tools and procedures) would be prohibitively expensive. Not to mention the fact that, here, only problem identification and definition, and model conceptualization were observed, recorded, measured and analyzed. If we were to develop the framework for the other steps (formulation and simulation, testing and evaluation, model-based analysis, etc.), the time needed to code and record the results would much greater, probably it would increase exponentially considering the cognitive difficulty associated with managing an increasing number of codes.

These weaknesses serve as points of departure for future steps in this line of research. First, we can think of ways of expediting coding, recording and analysis, to make the effort more efficient. The diagrammatic displays move the effort in this direction in terms of the form of illustration and analysis. We can examine ways of simplifying the codes, evaluating if the best practices coding is indeed necessary, and capturing the results simply in "summary" coding-sheets, as opposed to "detailed" coding-sheets. But, during the initial development of the framework and coding instruments, there appears to be great value in this in-depth qualitative approach.

Second, we need to enhance the coding rules, guidelines and procedures to improve reliability. More familiarity with the framework and better training of coders may improve the results for inter-coder reliability. Development of scales for each of the tensions, as opposed to pairs of polar forces, may also reduce the cognitive complexity of the coding task, in addition to providing better measurements (Martin and Bateson 1986). In any case, once we move beyond the exploratory state of this research, quantifying the

[18] For more weaknesses and limitations of this approach, see also Barton J. Bernstein's critique of Allison's *Essence of Decision*: http://www.findarticles.com/cf_dls/m1181/114/54336738/p1/article.jhtml.

tensions, as illustrated in the summary statistics and diagrammatic displays, seems to be a step forward.

Moving beyond exploration also means using research designs appropriate for theory testing and empirical assessment of the tensions. In sum, there are many ways in which this research can be improved, and many directions that it can take. In the next section, we conclude with one suggestion that we find particularly promising.

Some thoughts on a path toward "consensual learning"

We see this research evolving in a number of directions. For example, one way to use this awareness is to apply these tools/instruments, in fully developed protocols, as sophisticated "coaching instruments" (Benedetti and Reed 1998) used for "clinical supervision" (Carroll 1997, Sullivan and Glanz 2000, Acheson and Gall 2003) of modeling practice, providing systematic and on-time feedback to meeting facilitators and modelers/reflectors, as to the areas of the micro-world vs. boundary-object space covered during their modeling meetings and activities.[19]

We think these instruments and procedures would be most useful if they were combined with principles and heuristics for skillfully intertwining the micro-world and boundary-object approaches in practice. If we take for example the diagrammatic form of display of the results, and assuming that we had a discrepancy between a desired and an observed shape, it would be extremely useful to chart the course of the intervention to cover gaps in the two-dimensional space, using scripts and techniques particularly suited for the specific need at hand. For instance, if there were a gap in the empirical quadrant, we would select from the portfolio of scripts and techniques, those with an empirical emphasis. In this way, we could constantly monitor the space occupied by the "amoeba" representing the intervention as a whole, or its individual parts, all the way down to single scripts and exercises done with the client group.

[19] In the field of Education, "clinical supervision" is differentiated from "evaluation": supervision identifies what occurs within classrooms, emphasizing teachers' instructional performance, while evaluation also includes other areas such as the teacher's appearance, parent and peer relationships, attendance, promptness, and adherence to school policies. According to Carroll (1997), most teachers prefer supportive supervision, agree with the principles of clinical supervision, and prefer it. Clinical supervision is an ongoing, formative process that emphasizes the relationship between classroom performance and the teacher's espoused goals. Formative clinical supervision emphasizes "coaching" and feedback; collegiality is the key to its success. Peer coaching, an innovative outgrowth of clinical supervision, places the responsibility of supervision in the hands of the teachers themselves (Benedetti and Reed 1998). In Education, the tools and procedures for clinical supervision and coaching are highly developed, based upon research-based and empirically tested strategies, including techniques for qualitative and quantitative observation (Sullivan and Glanz 2000). The techniques of clinical supervision and coaching include process, goals, and models, and they are aimed at providing ways to work with teachers to help them improve their classroom teaching (Acheson and Gall 2003).

In SD-based interventions –particularly those involving management teams or stakeholder groups, in order to pursue insight (learning) and build consensus simultaneously, we need to bring together instrumentation that serves the objective of clinical supervision, as well as coaching, to steer the intervention in the desired directions, to adequately intertwine the goals of successfully negotiating a social order, while adequately representing reality. The CVA framework may be a well-suited role model to follow in the development of a theory to promote "consensual learning" (i.e., team learning). It has been through multiple stages of development, from proposal (Quinn and Rohrbaugh 1983), to testing, assessment and use (Quinn 1988, McCartt and Rohrbaugh 1989). We could learn a lot from this framework, both in term of the virtues we could borrow, as well as the problems we could avoid.

References

Acheson KA and MD Gall. 2003. *Clinical Supervision and Teacher Development: Preservice and Inservice Applications*. Hoboken, NJ: John Wiley & Sons.

Ackoff, RA. 1974. *Redesigning the Future: A Systems Approach to Societal Problems*. New York: Wiley.

Ackoff RA. 1979. The future of Operational Research is past. *Journal of the Operational Research Society* 30 (2): 93-104.

Allers R, R Johnson, DF Andersen, TP Lee, GP Richardson, J Rohrbaugh and AA Zagonel. 1998. Group model building to support welfare reform, part II: Dutchess county. *Proceedings of the 16th International Conference of the System Dynamics Society*. Québec, Canada (July 20-23).

Allison GT. 1971. *Essence of Decision: Explaining the Cuban Missile Crisis*. Boston, MA: Little, Brown and Company.

Akkermans HA and G Romme. 2003. System dynamics at the design-science interface. *Proceedings of the 21st International Conference of the System Dynamics Society*. New York City, USA (July 20-24).

Andersen DF and GP Richardson. 1997. Scripts for group model building. *System Dynamics Review* 13 (2): 107-129.

Andersen DF, GP Richardson and JAM Vennix. 1997. Group model building: Adding more science to the craft. *System Dynamics Review* 13 (2): 187-201.

Argyris C. 1999. *On Organizational Learning*. Malden, MA: Blackwell Publishers.

Babbie E. 1992. *The Practice of Social Research*. Belmond, CA: Wadsworth Publishing Company.

Bakken B, J Gould and D Kim. 1994. Experimentation in learning organizations: A Management Flight Simulator approach. In JDW Morecroft and JD Sterman (eds.). 1994. *Modeling for Learning Organizations*. Portland, OR: Productivity Press: 243-266.

Barlas Y and S Carpenter. 1990. Philosophical roots of model validation: Two paradigms. System Dynamics Review 6 (2): 148-166.

Benedetti TA and MK Reed. 1998. Supervising student teachers using peer coaching. Paper presented at the Annual Meeting of the National Council of Teachers of Mathematics. Washington, DC (April 3).

Berelson B. 1952. *Content Analysis in Communication Research*. New York: American Book–Stratford Press.

Berger P and T. Luckmann. 1966. *The Social Construction of Reality: A Treatise in the Sociology of Knowledge*. New York: Doubleday.

Black LJ, PR Carlile and NP Repenning. 2000. Improving the practice of process improvement. Working paper. Sloan School of Management. MIT. Cambridge, MA.

Brewer GD and OP Hall Jr. 1973. Policy analysis by computer simulation: The need for appraisal. *Public Policy* 21 (3): 343-365.

Brewer J and A Hunter. 1989. *Multimethod Research: A Synthesis of Styles*. Newbury Park, CA: SAGE Publications.

Bryson JM and CB Finn. 1995. Creating the future together: Developing and using shared strategy maps. In A Halachmi and G Bopuckaert (eds.). *The Enduring Challenges of Public Management*. San Francisco, CA: Jossey-Bass: 247-280.

Burrell G and G Morgan. 1979. *Sociological Paradigms and Organisational Analysis: Elements of the Sociology of Corporate Life*. Gower: Aldershot.

Carlile PR. 1997. Transformation knowledge in product development: Making knowledge manifest through boundary objects . Unpublished dissertation. University of Michigan, Ann Arbor.

Carlile PR. 2002. A pragmatic view of knowledge and boundaries: Boundary objects in new product development. *Organization Science* 13 (4): 442-455.

Carney TF. 1972. *Content Analysis: A Technique for Systematic Inference from Communications*. Winnipeg, Canada: University of Manitoba Press.

Carroll DH. 1997. A comparison of clinical supervision and evaluation. Paper presented at the Annual Meeting of the Southwest Educational Research Association. Austin, TX (January 23-26).

Coyle G. 2000. Qualitative and quantitative modelling in system dynamics: Some research questions. *System Dynamics Review* 16 (3): 225-244.

Coyle G. 2001. Rejoinder to Homer and Oliva. *System Dynamics Review* 17 (4): 357-363.

Davidsen PI. 1994. The System Dynamics approach to computer-based management learning environments. In JDW Morecroft and JD Sterman (eds.). 1994. *Modeling for Learning Organizations*. Portland, OR: Productivity Press: 301-316.

Diehl EW. 1994. Managerial microworlds as learning support tools. In JDW Morecroft and JD Sterman (eds.). 1994. *Modeling for Learning Organizations*. Portland, OR: Productivity Press: 327-338.

Eberlein RL and DW Peterson. 1994. Understanding models with Vensim. In JDW Morecroft and JD Sterman (eds.). 1994. *Modeling for Learning Organizations*. Portland, OR: Productivity Press: 339-348.

Eden C. 1989. Strategic options development and analysis. In J Rosenhead (ed.). *Rational Analysis in a Problematic World*. London: John Wiley & Sons.

Eden C. 1990. The unfolding nature of group decision support: two dimensions of skill. In C Eden and J Radford (eds.). *Tackling Strategic Problems: The Role of Group Decision Support*. London: SAGE Publications: 48-52.

Eden C, S Jones and D Sims. 1983. *Messing About in Problems: An Informal Structured Approach to their Identification and Management*. Oxford, England: Pergamon Press.

Forrester JW. 1961. *Industrial Dynamics*. Portland, Oregon: Productivity Press.
Forrester JW. 1969. *Urban Dynamics*. Waltham, MA: Pegasus Communications.
Forrester JW. 1971. *World Dynamics*. Waltham, MA: Pegasus Communications.
Forrester JW. 1975. Market growth as influenced by capital investment. In JW. Forrester. *Collected Papers*. Portland, OR: Productivity Press: 111-132.
Forrester JW. 1994. System dynamics, systems thinking, and soft OR. *System Dynamics Review* 10 (2-3): 245-256.
Forrester JW, NJ Mass and GW Low. 1974. The debate on world dynamics: A response to Nordhaus. *Policy Sciences* 5 (2): 169-190.
Gerbner G, OR Holsti, K Krippendorff, WJ Paisley and PJ Stone (eds.). 1969. *The Analysis of Communication Content*. New York: John Wiley & Sons.
Glazer M. 1972. *The Research Adventure: Promise and Problems of Field Work*. New York: Random House.
Gold RL. 1969. Roles in sociological field observation. In GJ McCall and JL Simmons (eds.). *Issues in Participant Observation*. Reading, MA: Addison-Wesley: 30-39.
Graham A. 2002. On positioning system dynamics as an applied science of strategy. Or: SD is scientific. We haven't said so explicitly, and we should. *Proceedings of the 20th International Conference of the System Dynamics Society*. Palermo, Italy (July 28-August 1).
Hines J. 2003. Modeling at conversation speed. *Proceedings of the 21st International Conference of the System Dynamics Society*. New York City, USA (July 20-24).
Homer J and R Oliva. 2001. Maps and models in system dynamics: A response to Coyle. *System Dynamics Review* 17 (4): 347-355.
Huz S, DF Andersen, GP Richardson and R Boothroyd. 1997. A framework for evaluating systems thinking interventions: An experimental approach to mental health system change. *System Dynamics Review* 13 (2): 149-169.
Isaacs W and PM Senge. 1994. Overcoming limits to learning in computer-based learning environments. In JDW Morecroft and JD Sterman (eds.). 1994. *Modeling for Learning Organizations*. Portland, OR: Productivity Press: 267-287.
Jackson MC. 1994. Critical systems thinking: Beyond the fragments. *System Dynamics Review* 10 (2-3): 213-229.
Janis I. 1982. *Groupthink: Psychological Studies of Policy Decisions and Fiascoes*. Boston: Houghton Mifflin.
Lane DC. 2001-A. Rerum cognoscere causas: Part I – How do the ideas of system dynamics relate to traditional social theories and the voluntarism/determinism debate? *System Dynamics Review* 17 (2): 97-118.
Lane DC. 2001-B. Rerum cognoscere causas: Part II – Opportunities generated by the agency/structure debate and suggestions for clarifying the social theoretic position of system dynamics. *System Dynamics Review* 17 (2): 97-118.
Lawler RW. 1987. Learning environment: Now, then and someday. In RW Lawler and M Yazdani (eds.). *Artificial Intelligence and Education, Volume I: Learning Environments and Tutoring Systems*. Norwood, NJ: Ablex.
Martin P and P Bateson. 1986. *Measuring behavior: An Introductory Guide*. Cambridge, England: Cambridge University Press.

Martínez-Moyano IJ and GP Richardson. 2002. An expert view of the system dynamics modeling process: Concurrences and divergences searching for best practices in system dynamics modeling. In *Proceedings of the 20th International Conference of the System Dynamics Society*. Palermo, Italy (July 28-August 1).

McCartt AT and J Rohrbaugh. 1989. Evaluation of group decision support effectiveness: A performance study of decision conferencing. *Journal of Decision Support Systems* 5: 243-253.

McCartt AT and J Rohrbaugh. 1995. Managerial openness to change and the introduction of GDSS: Explaining initial success and failure in decision conferencing. *Organization Science* 6 (5): 569-584.

Morecroft JDW. 1994. Executive knowledge, models and learning. In JDW Morecroft and JD Sterman (eds.). 1994. *Modeling for Learning Organizations*. Portland, OR: Productivity Press: 3-28.

Morecroft JDW and JD Sterman (eds.). 1994. *Modeling for Learning Organizations*. Portland, OR: Productivity Press.

Nordhaus B. 1973. World dynamics: Measurement without data. *Economic Journal* (December).

Papert S. 1980. *Mindstorms: Children, Computers, and Powerful Ideas*. New York: Basic Books.

Parsons T. 1959. General theory in sociology. In R Merton, L Broom and LS Cottrell Jr (eds.). *Sociology Today: Problems and Prospects*. New York: Basic Books.

Phillips LD. 1986. Computing to consensus. *Datamation International* 68 (October): 2-6.

Powell JH and RG Coyle. 2002. Setting strategic agendas: The use of qualitative methods in highly politicized contexts. *Proceedings of the 20th International Conference of the System Dynamics Society*. Palermo, Italy (July 28-August 1).

Quinn RE. 1988. *Beyond Rational Management: Mastering the Paradoxes and Competing Demands of High Performance*. San Francisco, CA: Jossey-Bass Publishers.

Quinn R and J Rohrbaugh. 1983. A spatial model of effectiveness criteria: Towards a competing values approach to organizational analysis. *Management Science* 29: 363-377.

Quinn R, J Rohrbaugh and MR McGrath. 1985. Automated decision conferencing: How it works. *Personnel* 62 (6): 49-55.

Randers J (ed.). 1980-A. *Elements of the System Dynamics Method*. Cambridge, MA: Productivity Press.

Randers J. 1980-B. Guidelines for model conceptualization. In J Randers (ed.). *Elements of the System Dynamics Method*. Cambridge, MA: Productivity Press: 117-139.

Reagan P and J Rohrbaugh. 1990. Group decision process effectiveness: A competing values approach. *Group Organizational Studies* 15: 20-43.

Reagan-Cirincione P, S Schuman, GP Richardson and SA Dorf. 1991. Decision modeling: Tools for strategic thinking. *Interfaces* 21 (6): 52-65.

Richardson GP. 1991. *Feedback Thought in Social Science and Systems Theory*. Philadelphia, PA: University of Pennsylvania Press.

Richardson, GP (ed.). 1996. *Modelling for Management* (2 volumes). Aldershot, UK: Dartmouth Publishing.

Richardson GP. 1999. Citation for winner of the 1999 Jay Wright Forrester Award: Jac A.M. Vennix. *System Dynamics Review* 15 (4): 375-377.

Richardson GP and DF Andersen. 1995. Teamwork in group model building. *System Dynamics Review* 11 (2): 113-137.

Richardson GP and AL Pugh III. 1981. *Introduction to System Dynamics Modeling with DYNAMO*. Cambridge, MA: Productivity Press.

Richardson GP, EF Wolstenholme and JDW Morecroft (eds.). 1994. *Systems Thinkers, Systems Thinking*. *System Dynamics Review*, 10 (2-3).

Roberts EB (ed.). 1978. *Managerial Applications of System Dynamics*. Cambridge, MA: The MIT Press.

Rogers J, R Johnson, DF Andersen, J Rohrbaugh, GP Richardson, TP Lee, and AA Zagonel. 1997. Group model building to support welfare reform in Cortland County. In *Proceedings of the 15th International Conference of the System Dynamics Society.* Istanbul, Turkey (August 19-22): 605-612.

Rohrbaugh J. 1989. Demonstration experiments in field settings: Assessing the process, not the outcome, of group decision support. In I Benbasat (ed.). *The Information Systems Research Challenge: Experimental Research Methods, Vol. 2*. Cambridge: Harvard Business School Publishing.

Rohrbaugh J. 1992. Cognitive challenges and collective accomplishments. In RP Bostrom, RT Watson and ST Kinney (eds.). *Computer Augmented Teamwork: A Guided Tour*. New York: Van Nostrand Reinhold: 299-324.

Rohrbaugh J. 2000. The use of system dynamics in decision conferencing: Implementing welfare reform in New York State. In GD Garson (ed.). *Handbook of Public Information Systems*. New York: Marcel Dekker: 521-533.

Rohrbaugh J and C Eden. 1990. Using the competing values approach to explore 'ways of working'. In C Eden and J Radford (eds.). *Tackling Strategic Problems: The Role of Group Decision Support*. London, England: SAGE Publications: 40-47.

Rosengren KE (ed.). 1981. *Advances in Content Analysis*. Beverly Hills, CA: SAGE Publications.

Rudolph, JW and NP Repenning. 2002. Disaster Dynamics: Understanding the Role of Quantity in Organizational Collapse. *Administrative Science Quarterly* 47: 1-30.

Senge PM. 1990. *The fifth discipline: The art and practice of the learning organization*. New York: Doubleday.

Star SL. 1989. The structure of ill-structured solutions: Boundary objects and heterogeneous distributed problem solving. In M Huhns and L Gasser (eds.). *Readings in Distributed Artificial Intelligence*. Menlo Park, CA: Morgan Kaufman.

Star SL and JR Greisemer. 1989. Institutional ecology, "translations," and boundary objects: Amateurs and professionals in Berkeley's Museum of Vertebrate Zoology. *Social Studies of Science* 19: 387-420.

Stenberg L. 1980. A modeling procedure for public policy. In J Randers (ed.). *Elements of the System Dynamics Method*. Cambridge, MA: Productivity Press: 292-312.

Sterman JD. 2000. *Business Dynamics: Systems Thinking and Modeling for a Complex World*. Boston, MA: The McGraw-Hill Companies.

Sullivan S and J Glanz. 2000. *Supervision That Improves Teaching: Strategies and Techniques*. Thousand Oaks, CA: Corwin Press.

Taggart W and D Robey. 1981. Minds and managers: On the dual nature of human information processing and management. *Academy of Management Review* 6: 187-195.

Vennix JAM. 1996. *Group Model Building: Facilitating Team Learning Using System Dynamics*. London: John Wiley & Sons.

Vennix JMA. 1999. Group model-building: Tackling messy problems. *System Dynamics Review* 15 (4): 379-401.

Vennix JMA, DF Andersen and GP Richardson (eds.). 1997. *Group Model Building*. *System Dynamics Review* 13 (2): 103-106.

Webb EJ, DT Campbell, RD Schwartz and L Sechrest. 1966. *Unobtrusive Measures: Nonreactive Research in the Social Sciences*. Chicago, IL: Rand McNally College Publishing Company.

Winch GW. 1993. Consensus building in the planning process: Benefits from a "hard" modeling approach. *System Dynamics Review* 9 (3): 287-300.

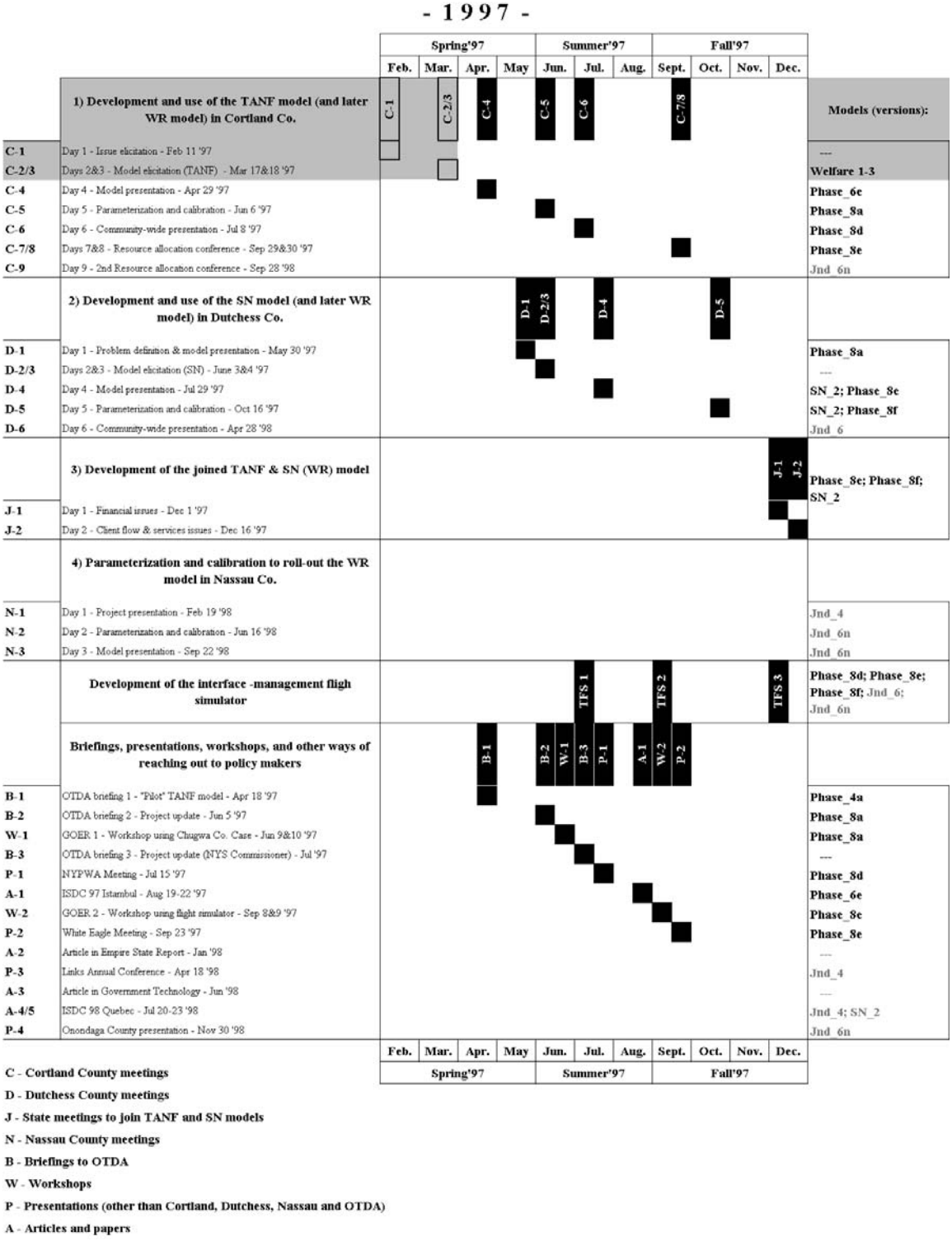
Zagonel AA. 2002. Model conceptualization in Group Model Building: A review of the literature exploring the tension between representing reality and negotiating a social order. *Proceedings of the 20th International Conference of the System Dynamics Society*. Palermo, Italy (July 28-August 1).

Zagonel AA. 2003. Using Group Model Building to inform welfare reform policy-making in New York State: A critical look. *Proceedings of the 21th International Conference of the System Dynamics Society*. New York City, USA (July 20-24).

Zagonel AA, DF Andersen and J Rohrbaugh. 1997. Report on the group model building conference in Cortland County: Issue elicitation meeting (February 11). Welfare Reform Project. Center for Policy Research. University at Albany. State University of New York.

Zagonel AA, J Rohrbaugh, GP Richardson and DF Andersen. 2004. Using simulation models to address "what if" questions about welfare reform. Accepted for publication in the *Journal for Policy Analysis and Management*.

APPENDIX 1 - SCHEDULE AND STREAMS OF ACTIVITIES OF THE WR PROJECT

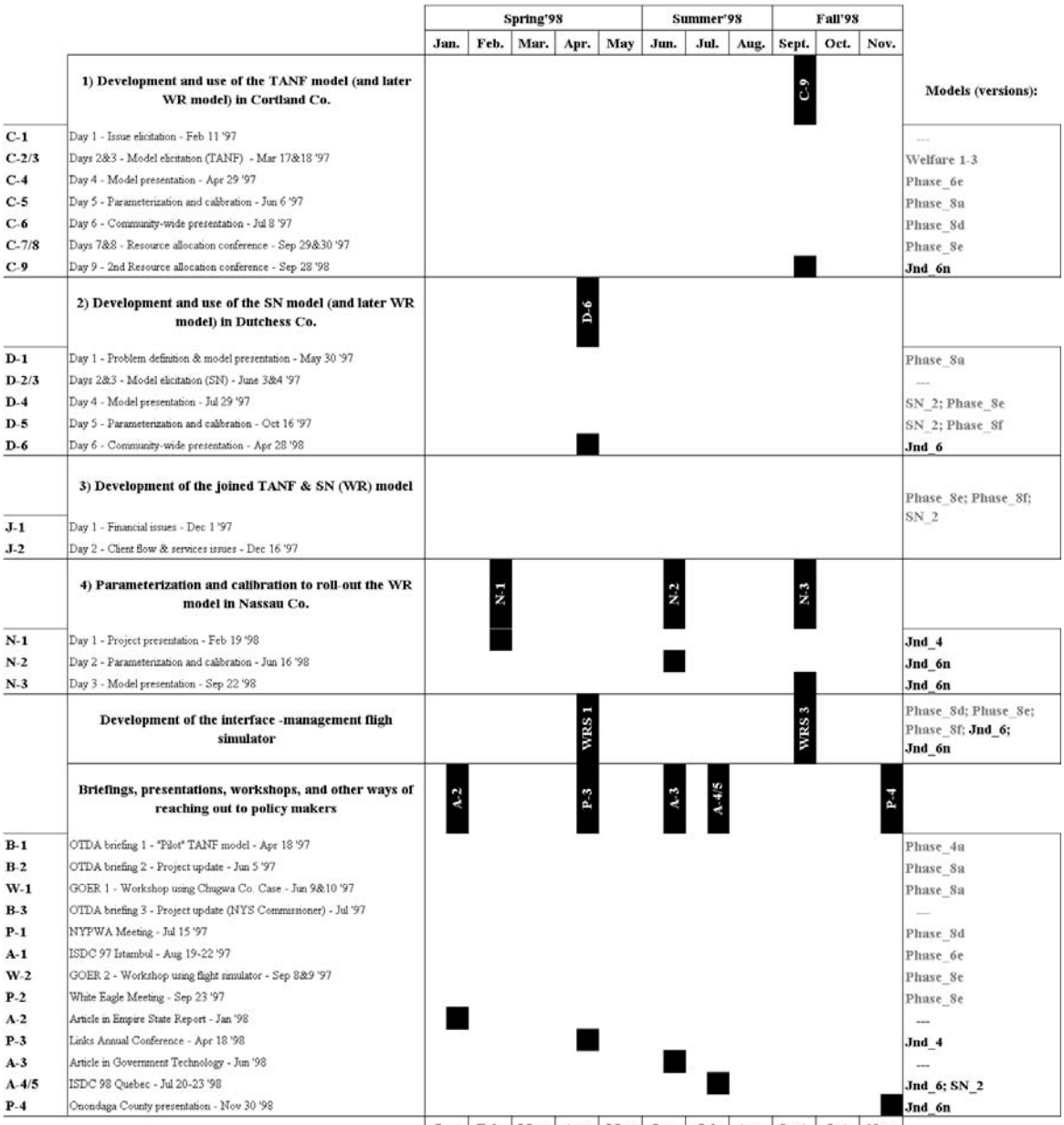


		Models (versions):
	1) Development and use of the TANF model (and later WR model) in Cortland Co.	
C-1	Day 1 - Issue elicitation - Feb 11 '97	---
C-2/3	Days 2&3 - Model elicitation (TANF) - Mar 17&18 '97	**Welfare 1-3**
C-4	Day 4 - Model presentation - Apr 29 '97	**Phase_6e**
C-5	Day 5 - Parameterization and calibration - Jun 6 '97	**Phase_8a**
C-6	Day 6 - Community-wide presentation - Jul 8 '97	**Phase_8d**
C-7/8	Days 7&8 - Resource allocation conference - Sep 29&30 '97	**Phase_8e**
C-9	Day 9 - 2nd Resource allocation conference - Sep 28 '98	Jnd_6n
	2) Development and use of the SN model (and later WR model) in Dutchess Co.	
D-1	Day 1 - Problem definition & model presentation - May 30 '97	**Phase_8a**
D-2/3	Days 2&3 - Model elicitation (SN) - June 3&4 '97	---
D-4	Day 4 - Model presentation - Jul 29 '97	**SN_2; Phase_8e**
D-5	Day 5 - Parameterization and calibration - Oct 16 '97	**SN_2; Phase_8f**
D-6	Day 6 - Community-wide presentation - Apr 28 '98	Jnd_6
	3) Development of the joined TANF & SN (WR) model	**Phase_8e; Phase_8f; SN_2**
J-1	Day 1 - Financial issues - Dec 1 '97	
J-2	Day 2 - Client flow & services issues - Dec 16 '97	
	4) Parameterization and calibration to roll-out the WR model in Nassau Co.	
N-1	Day 1 - Project presentation - Feb 19 '98	Jnd_4
N-2	Day 2 - Parameterization and calibration - Jun 16 '98	Jnd_6n
N-3	Day 3 - Model presentation - Sep 22 '98	Jnd_6n
	Development of the interface -management fligh simulator	**Phase_8d; Phase_8e; Phase_8f;** Jnd_6; Jnd_6n
	Briefings, presentations, workshops, and other ways of reaching out to policy makers	
B-1	OTDA briefing 1 - "Pilot" TANF model - Apr 18 '97	**Phase_4a**
B-2	OTDA briefing 2 - Project update - Jun 5 '97	**Phase_8a**
W-1	GOER 1 - Workshop using Chugwa Co. Case - Jun 9&10 '97	**Phase_8a**
B-3	OTDA briefing 3 - Project update (NYS Commissioner) - Jul '97	---
P-1	NYPWA Meeting - Jul 15 '97	**Phase_8d**
A-1	ISDC 97 Istambul - Aug 19-22 '97	**Phase_6e**
W-2	GOER 2 - Workshop using flight simulator - Sep 8&9 '97	**Phase_8e**
P-2	White Eagle Meeting - Sep 23 '97	**Phase_8e**
A-2	Article in Empire State Report - Jan '98	---
P-3	Links Annual Conference - Apr 18 '98	Jnd_4
A-3	Article in Government Technology - Jun '98	---
A-4/5	ISDC 98 Quebec - Jul 20-23 '98	Jnd_4; SN_2
P-4	Onondaga County presentation - Nov 30 '98	Jnd_6n

C - Cortland County meetings
D - Dutchess County meetings
J - State meetings to join TANF and SN models
N - Nassau County meetings
B - Briefings to OTDA
W - Workshops
P - Presentations (other than Cortland, Dutchess, Nassau and OTDA)
A - Articles and papers

APPENDIX 1 - SCHEDULE AND STREAMS OF ACTIVITIES OF THE WR PROJECT **(CONTINUED)**

- 1998 -



		Models (versions):
	1) Development and use of the TANF model (and later WR model) in Cortland Co.	
C-1	Day 1 - Issue elicitation - Feb 11 '97	---
C-2/3	Days 2&3 - Model elicitation (TANF) - Mar 17&18 '97	Welfare 1-3
C-4	Day 4 - Model presentation - Apr 29 '97	Phase_6e
C-5	Day 5 - Parameterization and calibration - Jun 6 '97	Phase_8a
C-6	Day 6 - Community-wide presentation - Jul 8 '97	Phase_8d
C-7/8	Days 7&8 - Resource allocation conference - Sep 29&30 '97	Phase_8e
C-9	Day 9 - 2nd Resource allocation conference - Sep 28 '98	**Jnd_6n**
	2) Development and use of the SN model (and later WR model) in Dutchess Co.	
D-1	Day 1 - Problem definition & model presentation - May 30 '97	Phase_8a
D-2/3	Days 2&3 - Model elicitation (SN) - June 3&4 '97	---
D-4	Day 4 - Model presentation - Jul 29 '97	SN_2; Phase_8e
D-5	Day 5 - Parameterization and calibration - Oct 16 '97	SN_2; Phase_8f
D-6	Day 6 - Community-wide presentation - Apr 28 '98	**Jnd_6**
	3) Development of the joined TANF & SN (WR) model	Phase_8e; Phase_8f; SN_2
J-1	Day 1 - Financial issues - Dec 1 '97	
J-2	Day 2 - Client flow & services issues - Dec 16 '97	
	4) Parameterization and calibration to roll-out the WR model in Nassau Co.	
N-1	Day 1 - Project presentation - Feb 19 '98	**Jnd_4**
N-2	Day 2 - Parameterization and calibration - Jun 16 '98	**Jnd_6n**
N-3	Day 3 - Model presentation - Sep 22 '98	**Jnd_6n**
	Development of the interface -management fligh simulator	Phase_8d; Phase_8e; Phase_8f; **Jnd_6; Jnd_6n**
	Briefings, presentations, workshops, and other ways of reaching out to policy makers	
B-1	OTDA briefing 1 - "Pilot" TANF model - Apr 18 '97	Phase_4a
B-2	OTDA briefing 2 - Project update - Jun 5 '97	Phase_8a
W-1	GOER 1 - Workshop using Chugwa Co. Case - Jun 9&10 '97	Phase_8a
B-3	OTDA briefing 3 - Project update (NYS Commissioner) - Jul '97	---
P-1	NYPWA Meeting - Jul 15 '97	Phase_8d
A-1	ISDC 97 Istambul - Aug 19-22 '97	Phase_6e
W-2	GOER 2 - Workshop using flight simulator - Sep 8&9 '97	Phase_8e
P-2	White Eagle Meeting - Sep 23 '97	Phase_8e
A-2	Article in Empire State Report - Jan '98	---
P-3	Links Annual Conference - Apr 18 '98	**Jnd_4**
A-3	Article in Government Technology - Jun '98	---
A-4/5	ISDC 98 Quebec - Jul 20-23 '98	**Jnd_6; SN_2**
P-4	Onondaga County presentation - Nov 30 '98	**Jnd_6n**

C - Cortland County meetings
D - Dutchess County meetings
J - State meetings to join TANF and SN models
N - Nassau County meetings
B - Briefings to OTDA
W - Workshops
P - Presentations (other than Cortland, Dutchess, Nassau and OTDA)
A - Articles and papers

APPENDIX 2 – "DETAILED" SUMMARY OF THE SEVEN RECORDS EXAMINED IN THE PILOT STUDY

Record number	Chronology	Record identification	Media type	Number of pages	Title of document	Content of document	Location of meeting	Duration of meeting		Type of meeting	Meeting participants								Level of effort (persons *hours)
								Begin/end times	Number of hours		Client team			Modeling team				Number of persons in attendance	
											Definition	Quant.	Names	Definition	Quant.	Roles	Names		
R-01	(March 3)	Project proposal	Electronic file (text, graphics and spreadsheet)	8	System Dynamics Modeling for Welfare Reform: A Proposal	Introduction; Project schedule (Time line); Deliverables; Qualifications; History of DC using SD; Proposed budget	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
R-02	Feb 11	Issue elicitation meeting	Electronic file (text, graphics and spreadsheet)	17	GMB for Social Services in Cortland County (Day 1)	List of participants and observers; Introduction; Hopes and fears exercise; Stakeholder analysis; Resource inventory; Data estimates; Policy levers; Reference modes; Explanation of	Cortland, NY	9AM-5PM	7.0	GMB meeting	Client team plus key stakeholders and observers	14	Rogers, Johnson and others (see p. 3)	Incomplete	3	Facilitator, process coach, recorder	David, John and Aldo	17	119
R-03	Feb 25	Organizational meeting	E-mail and hand-written notes	5	n.a.	Announcement; Project product; Policy choices, options and issues; Elicitation approach; Brainstorming behavior and structure; Next steps	Albany, NY	2-4PM	2.0	Meeting of the modeling team	n.a.	n.a.	n.a.	Complete	4	Facilitator, reflector, process coach, recorder	David, George, John, Aldo	4	8
R-04	Mar 7	1st preparation meeting	Hand-written notes and photocopied graphics	10	n.a.	Project purpose; NYS welfare reform; TANF; Safety net; Resources; Race to the bottom; Work participation targets; GMB/SD framework and method; Concept models; 2-day plan	Albany, NY	10AM-12PM	2.0	Expanded meeting of the modeling team	n.a.	n.a.	n.a.	Incomplete	5	Facilitator, process coach, recorder, domain experts	David, John, Aldo, Irene and Dana	5	10
R-05	Mar 12	2nd preparation meeting	Hand-written notes and electronic text	6	n.a.	Planning and preparation for the model conceptualization meetings; TANF; Safety net; Key system states; Plumbing vs. wiring; Day plan for March 17	Albany, NY		2.0	Expanded meeting of the modeling team	n.a.	n.a.	n.a.	Complete and expanded	6	Facilitator, reflector, process coach, recorder, domain experts	David, George, John, Aldo, Irene and Dana	6	12
R-06	Mar 13-14	3rd preparation meeting	Hand-written notes; Vensim diagrams, graphs, equations and table functions; Photocopied Stella diagram and graphs	15	n.a.	DAPS brown-bag presentation on WR concept models (purpose, objectives, illustration); Layers 1, 2 and 3; Modeler's meeting (structure, parameters and table functions); Technology and process issues	Albany, NY	12:30-1:30PM and ...	2.0	Modeler's meeting	n.a.	n.a.	n.a.	Incomplete	3	Reflector, modelers and recorder	George, Aldo and Mohammad	3	6
R-07	Mar 17-18	Model conceptualization meetings	Electronic file (text, graphics and spreadsheet)	31	GMB for Social Services in Cortland County (Days 2 and 3)	Participants; Review of Day 1; Concept models; Client stock-and-flow diagrams; Policy (options and clusters); Resources (inventories, clusters, allocation); Diversion; Assessment and monitoring (case management); Employment services (training, child care, transportation, job readiness, education, low-need; high-need); Self-sufficiency (recidivism, job development); Safety Net; Agreements and definitions; Data estimates (client stock-and-flow,	Syracuse, NY	9AM-5PM on both days	14.0	GMB meetings	Client team plus key stakeholders and observers	20	Rogers, Johnson and others (see p. 4)	Complete	6	Facilitator, reflector, process coach, recorders	David, George, John, Aldo, Mohammad and Dana	26	364

n.a. - not applicable

APPENDIX 3. A CREATIVE ILLUSTRATION OF THE DICHOTOMOUS VIEW OF MODELS IN GMB
(Copied from Zagonel 2002, Table 3)

Question: How do intervenors and participants view the model they are building?

Steps of the SD method:	Model as "micro-world":	Model as "boundary-object":
1. Problem identification and definition	▪ Monolithic client ▪ Preexisting problem ▪ The modeling purpose is to identify and solve a problem	▪ Multiple constituencies ▪ Socially constructed problems ▪ Multiple purposes, starting with negotiating a shared view
2. Model conceptualization	▪ Getting at the facts ▪ Envisioning the structure capable of reproducing the problematic behavior	▪ Agreeing upon "reality" ▪ Model is a synthesis of the group's negotiated view of "reality" (issues of scope and level of aggregation)
3. Model formulation and simulation	▪ Build a quantifiable model and test the dynamic hypothesis ▪ Modeler's ownership of the model	▪ Should we even bother building a quantifiable model? ▪ Group's ownership of the model
4. Model testing and evaluation	▪ Organized approach to model testing and evaluation ▪ Modeler is free to review and adjust conceptualization and formulation	▪ Group judges model for structural and behavioral correspondence, mostly in terms of face-validity ▪ Significant changes in model conceptualization and formulation need to be checked with the group
5. Model based problem analysis and policy experimentation	▪ Structural analysis of the problem ▪ Experimentation with new structure	▪ Strategic analysis of interrelated problems ▪ Experimentation with alternative strategies and scenarios
6. Understanding and discernment	▪ What's causing the problem? ▪ How can we fix it?	▪ Do we agree on the problem? Do we share a view of the system? ▪ Are we ready to make a decision
7. Policy implementation (action) and outcomes	▪ Structural change ▪ Change resulting from "new" understanding regarding relationship between structure and behavior	▪ Changes in goals, objectives and strategy ▪ Change resulting from agreements in goals, objectives and strategies

APPENDIX 4 – PRE-TEST OF INTER-CODER RELIABILITY

We used a pre-test of inter-coder reliability to assess the clarity of the coding rules, and to evaluate if the author and two other coders would agree in the application of the best practices and dichotomy codes. We used Record number 2, the report of the issue elicitation meeting in Cortland County. All coders were experienced system dynamicists.

The author divided the record into nine separate items, and designed a "summary" coding-sheet to capture the codes for each item. The coders were asked to assign both types of codes to each of the items (best practices and dichotomy). Each item could be assigned a primary and a secondary code for each framework. Codes needed not be applied if none were found suitable for the specific item.

The results produced by all three coders are condensed in a summary coding-sheet reproduced at the end of this Appendix. Primary codes for both best practices and dichotomy were applied for most items by all three coders. In some cases secondary codes were used.

We used a simple mechanism to measure inter-coder reliability. We measured the extent of overlap between the primary code, and the primary or secondary code for each coder. The results are captured in the tables below, separated for best practices and dichotomy coding.

Best practices coding

Coders:	A	B	C
A	100%	6/7 86 %	6/7 86%
B		100%	6/8 75%
C			100%

Dichotomy coding

Coders:	A	B	C
A	100%	5/9 56%	3/9 33%
B		100%	2/7 29%
C			100%

We can summarize the results as follows:

1. Inter-coder reliability was higher for the more familiar framework, best practices in system dynamics, than for the micro-world vs. boundary-object dichotomy. For best practices, the extent of overlap in code assignment ranged between 75 and 86 percent, while for the dichotomy, the extent of overlap was much lower, between 29 and 56 percent;

2. The extent of overlap between the primary coder (author) and each of the secondary coders was greater than the degree of agreement among the secondary coders themselves. For best practices, there was agreement 86 percent of the time between the primary coder and the secondary coders, while only 75 percent of the time among the secondary coders. For the dichotomy, there was agreement 33 percent or more of the time between the primary coder and the secondary coders, while only 29 percent of the time among the secondary coders;

3. Inter-coder reliability was very low for dichotomy coding. The coders experienced more difficulty using dichotomy codes, and were less likely to agree.

These results suggest that further improvements need to be made in the coding rules, particularly for the dichotomy codes. Also, the results could improve with better training and more familiarity with the framework.

Given the low degree of inter-coder agreement for the dichotomy framework (between 29 and 56 percent), the results of this pilot study should be taken as suggestive, rather than conclusive. Also, the instruments developed (particularly coding rules, coding sheets, and coding procedures) are not yet at a stage that would allow the results to be readily replicated successfully.

Summary Coding Sheet – Inter-coder Reliability

Date of document:	Description:	Coder names:
February 11, 1997	Report, Cortland Co., Day 1 – Issue elicitation meeting (R-02)	A) Aldo B) *Mohammad* C) Rod

Item coded	Page numbers	CODES APPLICABLE TO ITEM											
		Best Practices (Number codes)						MW v. BO Dichotomy (Letter codes)					
		Primary			Secondary			Primary			Secondary		
		A	B	C	A	B	C	A	B	C	A	B	C
List of participants and observers	3							F	*F*	F			
Introduction (Rogers/Andersen)	4	2	*2*	2	6			D			B		
Hopes and fears exercise	5	1	*1*	1	2	*2*		F	*M*	M	B	*F*	
Stakeholder analysis	6, 7			1				F	*F*	B			
Resource inventory	8	10	*8*	10	8	*10*		K	*K*	M			
Data estimates	10, 14, 17	10	*10*	10	8			M	*L*	M	O		
Cortland TANF major policy components	11	1	*2*	1	2		2	D	*D*				
Reference modes	11, 12, 13, 15, 16	3	*3*	3	9			H	*K*	H			
Explanation of GMB	13	2	*2*					L			M		

APPENDIX 5 – THE MEANING OF COLORS

Moderator – neutral voice (green)

Symbolizes the balancing forces, peace, compassion and renewal. Moderation, harmony, nurturing and diplomacy are its qualities. It calms the energies and prevails over excess. Like nature it can draw away energy from being too physical or mental and introduce a stillness that produces a contemplative atmosphere. Green increases the sense of wonder, and brings to you that "let it be" feeling.

Ms. MW – pursuit of insight/knowledge (yellow)

Symbolizes the mental force, clarity, perception, understanding and wisdom. Confidence, curiosity and practical application of wisdom are its qualities. Humor and mental detachment make yellow significant for bringing new life to ways of thinking and seeing. Yellow brings rich meaning to activities. It always seems to bring crystallization to events and issues.

Mr. BO – pursuit of mutual understanding/consensus building/shared ownership (blue)

Symbolizes the communicative force, speech, messages and ideas. It relaxes and opens the mind to share thoughts and ideas. Idealism, sincerity, mental empathy and relaxation are associated with blue. It brings out affection, loyalty and inspiration. It is the color of friendship and develops that unconditional bonding. The color inspires trust and steadiness.

Participant – participant observation and interpretation (red)

Symbolizes the vital force, energy, passion, courage and action. It is associated with leadership, power, the will and the body. Spontaneity, impulsiveness and the instinctual forces are its qualities. It stimulates activity, intensity and extroversion. Red brings out the revolutionary and leads us into affirmative thought and action. Red strengthens our resolve to pursue something.

APPENDIX 6 – "DETAILED" CODING-SHEETS FOR RECORDS 1, 3, 4, 5, 6 AND 7

Summary Tables 1-A: Best practices content in the project proposal (R-01)

BPs Present	Problem definition	Model concept.	Total (By type)	BPs Absent	Problem definition	Model concept.	Total (By type)
Consensual	1	0	1	Consensual	4	3	7
Non-consensual	2	0	2	Non-consensual	0	3	3
Total (By step)	3	0	3	Total (By step)	4	6	10

Problem identification and definition, Consensual:
2) Purpose
i. The purpose of the project is to use system dynamics modeling to assist local social services districts to plan for changes necessary as a result of federal and state welfare reform (p. 1) ii. The approach will be to develop county-specific computer models (p. 1) iii. These models will serve as a representation of the county's human services delivery systems (p. 1) iv. They will be capable of generating a large variety of scenarios so that "what if" policy questions concerning welfare reform options can be tested, allowing policy makers to examine both short-term and long-range consequences of policy decisions (p. 1) v. A major goal of the project is for NY State to be prepared to assist other counties throughout the State with their welfare reform planning and implementation decisions in interactive strategic planning group processes (pp. 1 and 2)

Problem identification and definition, Non-consensual:
6) Prior experience
vi. The modeling team brings together experts with detailed and deep understanding of the unique circumstances and fundamental problems that exist in delivering human services (p. 3), and has extensive experience with the development of SD models for public sector organizations, especially human services agencies (pp. 5 and 6)
7) Generic model
vii. From these county specific models, a flight simulator will be developed that can be used as part of a state-facilitated process of interactive welfare reform planning; the simulator will be flexible enough that it can be used effectively with counties that are not involved in the model building effort (p.1)

Summary Tables 1-B: MW&BO content in the project proposal (R-01)

Problem identification and definition:	
Micro-world perspective:	Boundary-object perspective:
	Problem:
	B) Messy
	x. Set out to model "the system": the computer model will be a representation [of the system] … as articulated and integrated by the group members themselves (item iii) (p.1)
	Purpose:
C) Problem solving	D) Consensus building
xi. Emphasized *understanding* dynamic complexity and learning feedback-rich insights (p.1)	xii. Purpose was broadly defined, from building a representation of the system to strategic planning (items i through iv) (pp. 1 and 2) xiii. Emphasized model *ownership* (p. 1)
	Client/audience:
	F) Constituencies
	xiv. Proposed to work with a diverse group of stakeholders (counties and state; social services and other agencies; executive agencies and legislature; public and nonprofit) of size 10 to 18 participants per meeting (pp. 1 and 2)

Model conceptualization:	
Micro-world perspective:	Boundary-object perspective:
	Objectiveness:
	M) Views/opinions
	xv. Proposed to elicit group members' representation (views) of the system (item iii) (p.1)
	Boundary:
	O) Negotiated/broad
	xvi. Proposed to facilitate the negotiation of a shared-view of the system (item iii) (p. 1) xvii. The participants will define the boundary of the model (level of aggregation and scope) (p. 2)
	Role of the modeler:
P) Reflector	R) Facilitator
xviii. Proposed to act as analysts and teachers (consultants/educators) (p. 3) xix. Proposed to focus *on insight* through extracting and framing lessons learned, preparing learning modules, and conducting training sessions (pp. 2 and 3)	xx. Proposed to work as facilitators (p. 3) xxi. Proposed to focus *on group processes and procedures* (group dynamics) through structuring participatory group approaches for model elicitation and use (pp. 1 and 2)

Summary Tables 2-A: Best practices content in the February 11th meeting (R-02)

BPs Present	Problem definition	Model concept.	Total (By type)	BPs Absent	Problem definition	Model concept.	Total (By type)
Consensual	4	3	7	Consensual	1	0	1
Non-consensual	1	0	1	Non-consensual	1	3	4
Total (By step)	5	3	8	Total (By step)	2	3	5

Summary Tables 3-A: Best practices content in the February 25th meeting (R-03)

BPs Present	Problem definition	Model concept.	Total (By type)	BPs Absent	Problem definition	Model concept.	Total (By type)
Consensual	2	1	3	Consensual	3	2	5
Non-consensual	1	2	3	Non-consensual	1	1	2
Total (By step)	3	3	6	Total (By step)	4	3	7

Problem identification and definition, Consensual:

1) Problem

i. Governor's policy proposal v. the block grant policy structure (p. 2)
ii. Attractiveness of a county under a "no one will freeze or starve policy" (p. 3)
iii. Shift in funding of client services from federal to state dollars due to loss of federal eligibility, combined with constitutionally mandated support at the State level (p. 3)
iv. Consequences of structural unemployment on loss of eligibility under the fixed 5-year maximum cumulative length of stay (p. 4)
v. Impact on the Supplemental Security Income (SSI) program of shifting elderly clients and clients with disabilities (p. 4)

2) Purpose

vi. To develop a policy-rich flight simulator for strategy experimentation, based upon what counties can do (are doing) under the circumstances, to assess the implications of shifting certain levers, i.e., adopting specific strategies (p. 2)

Problem identification and definition, Non-consensual:

6) Prior experience

vii. Proposed to reexamine the source of complexity in the last project done in social services, JOBS (p. 4)

Model conceptualization, Consensual:

9) Conceptual building blocks

viii. Proposed to use concept models to start off model elicitation process with the client group (pp. 1 and 5).

Model conceptualization, Non-consensual:

12) Dynamic hypotheses (2)

ix. Considered building a model based upon one dynamic hypothesis, e.g., involving compensating feedback (marginal jobs and SSI) (p. 5)
x. Proposed to build concept models based upon a dynamic hypothesis (p. 5)

13) Stock-and-flow

xi. Drew structures depicting accumulations of clients and resources (p. 3)

Summary Tables 3-B: MW&BO content in the February 25th meeting (R-03)

Problem identification and definition:	
Micro-world perspective:	Boundary-object perspective:
Problem:	
	B) Messy
	xii. Acknowledged (implicitly) that many issues are involved (see Tables 3-A, item 1)
Client/audience:	
	F) Constituencies
	xiii. Stakeholders pursuing different goals; add 5-6 state actors (p. 3)
Synthesis:	
	H) None
	xiv. Discussed problems in broad terms (pp. 3, 4 and 5)

Model conceptualization:	
Micro-world perspective:	Boundary-object perspective:
Intrusiveness:	
J) Dynamic hypothesis 2	K) Non-intrusive
xv. Proposed a top-down approach based upon one dynamic hypothesis and starting from concept models (p. 5)	xvi. Proposed adoption of a flexible elicitation approach and "low goals" (p. 3) xvii. Set out to prepare an elicitation scheme separate from top-down tasks (p. 5)
Objectiveness:	
L) Theories/facts	M) Views/opinions
xviii. Need to know more about the Governor's plan (p. 3)	xix. Knowledge of the people in the room is not enough (p.3)
Role of the modeler:	
P) Reflector	R) Facilitator
xx. Acted as analyst/teacher: primary concern in developing concept models in preparation for the model conceptualization meetings (p. 1) xxi. Focused primarily on insight: "compensating feedback" v. "shifts from one equilibrium to another" (p. 5)	xxii. Discussed alternative model elicitation approaches using feedback-loops v. stock-and-flow diagrams (p. 3) xxiii. Concern with the design of conceptualization meetings (p. 4) xxiv. Concern with learning more about the content of the problem (p. 4)

Summary Tables 4-A: Best practices content in the March 7th meeting (R-04)

BPs Present	Problem definition	Model concept.	Total (By type)	BPs Absent	Problem definition	Model concept.	Total (By type)
Consensual	2	3	5	Consensual	3	0	3
Non-consensual	0	1	1	Non-consensual	2	2	4
Total (By step)	2	4	6	Total (By step)	5	2	7

Problem identification and definition, Consensual:

1) Problem

i. Issue is also political; power struggle between the Governor and the social services bureaucracy: welfare department's responsibilities have been tossed around; Governor would not allow them to work on all 3 programs (to families, individuals and disabled); Governor can dismantle agencies but needs legislative approval to change programs (pp. 3 and 9)
ii. Modeling programs is problematic: federal requirements ≠ Governor's proposal ≠ Cortland County wants to do (p. 3), still counties will have a fair amount of latitude, as they do today (p. 5)
iii. "No one will starve or die" policy may trigger issue of relative attractiveness across counties (p. 5)
iv. Article 17 of the State Constitution provides a safety net for those not eligible to federal aid (pp. 7 and 8)
v. Rising federal work participation targets (p. 10)

2) Purpose

vi. Build a model that gives county managers discretion regarding how to run programs, to let them see the implications of a "joint" set of choices, constrained by budgetary and state policy (p. 1)
vii. Create a training flight simulator interface for managers to make choices and test alternative policies/strategies (p. 1)

Model conceptualization, Consensual:

8) Creativity and flexibility

viii. 2-day meeting to have three parts: 1st - precisely planned, 2nd - well planned, and 3rd - loosely planned (p. 6)
ix. Concept models are "creatively" wrong so that participants are thrown towards "correcting" the model (p. 7)

9) Conceptual building blocks

x. Began brainstorming three-layer concept model to start off pair of model conceptualization meetings (pp. 1, 2, 6 and 7)
xi. Used stock-and-flow diagrams (pp. 2 and 8), and graphs of behavior over time (p. 2)

10) Key stocks

xii. Referred to the following key stocks: 1-At risk, 2-TANF (People on assistance, Clients), 3-Employed, 4-Program quality (Resources), and 5-People on safety net

Model conceptualization, Non-consensual:

13) Stock-and-flow

xiii. Drew client-flow structures (pp. 2 and 8)

Summary Tables 4-B: MW&BO content in the March 7th meeting (R-04)

Problem identification and definition:	
Micro-world perspective:	Boundary-object perspective:
	Problem:
	B) Messy
	xiv. Acknowledged (implicitly) that many issues are involved (see Tables 4-A, item 1)
	Client/audience:
	F) Constituencies
	xv. Model should be drawn "big enough" for participants to see themselves (p. 6)
	Synthesis:
	H) None
	xvi. Defined problem/purpose broadly: did not specify what specific issues would be addressed in the model; did not clarify what policies/strategies would be examined in simulations (see Tables 4-A, items 1 and 2)

Model conceptualization:	
Micro-world perspective:	Boundary-object perspective:
Intrusiveness:	
	K) Non-intrusive xvii. Proposed to provide some structure to provoke and guide discussions (concept models; scripts for creating an inventory of clients and resources, and to examine funding sources), but avoided restraining conceptualization with framework (pp. 1 and 4) xviii. Adopted inductive, bottom-up approach: proposed to postpone expert's view until after conceptualization meetings in Cortland County, in a process of "stepping back" to see what client group said/did (p. 5) xix. Concept models are "creatively" wrong so that participants are thrown towards "correcting" the model (p. 7)
Objectiveness:	
L) Theories/facts xx. Need to "step back" and use expert knowledge to revisit what client group has said/done (p. 5) xxi. Sought to understand welfare reform (reorganization and issues) from factual sources (pp. 9 and 10)	M) Views/opinions xxii. Spend two days letting client group tell us what system really looks like (p. 1)
Boundary:	
	O) Negotiated/broad xxiii. Need to stay close to what client group wants to do (p. 5) xxiv. Model should be drawn "big enough" for participants to see themselves (p. 6)
Role of the modeler:	
P) Reflector xxv. Proposed to use concept models to convey/explain system dynamics (p. 1) xxvi. Proposed to use flight simulator in training managers (p. 1) xxvii. Proposed to bring in an outside perspective: "step back" and use expert knowledge to revisit what client group has said/done (p. 5)	R) Facilitator xxviii. Acted as learner and blended with the group: spend two days letting client group tell us what system really looks like (p. 1); need to stay close to what client group wants to do (p. 5) xxix. Focused on procedure: 2-day meeting to have three parts: 1st - precisely planned (start off with concept models, 2nd - well planned (scripts for creating an inventory of clients and resources, and to examine funding sources), and 3rd - loosely planned (p. 1, 4 and 6)

Summary Tables 5-A: Best practices content in the March 12th meeting (R-05)

BPs Present	Problem definition	Model concept.	Total (By type)	BPs Absent	Problem definition	Model concept.	Total (By type)
Consensual	2	3	5	Consensual	3	0	3
Non-consensual	0	2	2	Non-consensual	2	1	3
Total (By step)	2	5	7	Total (By step)	5	1	6

Problem identification and definition, Consensual:
1) Problem
i. When the welfare reform transition is done, what are the clusters of people that will be unable to find jobs? Who will end up, for instance, in SSI? (pp. 1, 2 and 3) ii. Will reduced federal government funding overwhelm charity capacity? (p. 3) iii. Will Federal Reserve monetary policy undermine local employability? (p. 3) iv. Relative attractiveness and migration (p. 3) v. Coordination [between social services and labor] in terms of employability assessment and employment services; develop shared employability assessment instrument (p. 3) vi. Proposed the problem as a transition to a new equilibrium (p. 5)
2) Purpose
vii. Policy/strategy exploration: what are the policy options to be considered? (p. 3) viii. Consensus building: develop shared employability assessment instrument with county employment services [labor department] (p. 3)

Model conceptualization, Consensual:
8) Creativity and flexibility
ix. Proposed not to reify a stock-and-flow structure, but to start with listing clients and resources, and also to do some "wiring" (causal-loop diagrams) (p. 2) x. Proposed alternative feedback effects to embed in the model (items ii, iii and iv above) xi. Propose to approach conceptualization from different angles: concept models, client flow, inventory of resource sectors, bottle necks, feedback vignettes regarding client flow decision points and resource allocation decisions (pp. 5 and 6)
9) Conceptual building blocks
xii. Referred to the preparation of the two/three-layer conceptual model (p. 1) xiii. Used stock-and-flow diagrams (pp. 2 and 3) xiv. Proposed to use concept models, client-flow and feedback-loop diagrams (pp. 5-6)
10) Key stocks
xv. Proposed to pursue tentative agreement about what are the key system states that define the system (pp. 2 and 5)

Model conceptualization, Non-consensual:
11) Causal loops
xvi. Proposed to extract feedback vignettes for both client flow and resource allocation decisions, and to sketch feedback loops (p. 5) xvii. Proposed to "leave hanging" feedback plugs, such as "probability of successful job placement" (p. 5)
13) Stock-and-flow
xviii. Stock-and-flow structures were sketched (pp. 2 and 3) xix. Proposed to draw a stock-and-flow structure identifying client "end states" and flow paths (pp. 5 and 6)

Summary Tables 5-B: MW&BO content in the March 12th meeting (R-05)

Problem identification and definition:	
Micro-world perspective:	Boundary-object perspective:
Problem:	
A) Preexisting	B) Messy
xx. Proposed the problem as a transition to a new equilibrium (p. 5)	xxi. Acknowledged (implicitly) that many issues are involved (see Tables 5-A, items 1 and 2) xxii. Engaged in modeling the system: proposed to generate a list and use policy options to make decisions about system boundary (p. 3); stated "first we assemble all of the 'stuff' that we want to play with within the system boundary" (p. 5) xxiii. Difficulty defining TANF [as program, resource stock or client group] (p. 2)
Purpose:	
	D) Consensus building
	xxiv. Coordination [between social services and labor] in terms of employability assessment and employment services; develop shared employability assessment instrument (p. 3)
Client/audience:	
	F) Constituencies
	xxv. Worked with a diverse group of stakeholders: communication that four new participants were added to the original group, as observers from the State (p. 1)
Synthesis:	
G) Dynamic hypothesis 1	H) None
xxvi. "'End states' discussion will focus on where will clients wind up. This focuses us on the transition to some new equilibrium problem" (p. 5)	xxvii. Defined problem/purpose broadly (Tables 5-A, item 1 and 2) xxviii. Discussed structure (and policy options) uncoupled from behavior (pp. 2 and 3)

Summary Tables 5-B: MW&BO content in the March 12th meeting (R-05) - continued

Model conceptualization:	
Micro-world perspective:	Boundary-object perspective:
Intrusiveness:	
J) Dynamic hypothesis 2	K) Non-intrusive
xxix. Proposed to pursue major causal loops hypothesized to determine the behavior of key variables, based upon a set of feedback effects (items ii, iii and iv above), as opposed to conceptualizing the model based upon a stock-and-flow structure (pp. 1 and 2)	xxx. Proposed to provided some structure to provoke and guide discussions, but avoided restraining conceptualization with framework: proposed not to reify a stock-and-flow structure (p. 2) xxxi. Changed "lenses": proposed to start with resource and client "list", then aggregate; build stock-and-flow structure; do some "wiring" (maybe first) (p. 2) xxxii. Adopted bottom-up approach: "first we assemble all of the 'stuff' that we want to play with within the system boundary" (p. 5); "first do a brainstorm of all possibilities (feedback controlling resource allocation decisions), then rank them for discussion" (p. 6)
Objectiveness:	
L) Theories/facts	M) Views/opinions
xxxiii. "We will not do a numbers exercise again" (?) (p. 6)	xxxiv. Proposed to elicited views and opinions: end states, flow paths, decision rules controlling flows and resource allocations
Boundary:	
N) Guided/parsimonious	O) Negotiated/broad
xxxv. Proposed to focus conceptualization upon small number of stocks (p. 2) xxxvi. Proposed to use policy options to restrict size of model boundary (p. 3) xxxvii. Propose to have modeler suggest a [polished] stock-and-flow structure after client group discussion (p. 5-6), and "clean up" sketches coming from the group (p. 6)	xxxviii. Facilitated the negotiation of a shared view of the system: proposed to pursue tentative agreement about what are the key system states that define the system, as well as the flow point and the key set of movements (p. 2) xxxix. Struggled with level of aggregation and scope issues: proposed to begin with a list of resources and clients and, then, aggregate (p. 2)
Role of the modeler:	
P) Reflector	R) Facilitator
xl. Focused on insight: what are the interesting things that can be done/shown with this model (e.g., compensating feedback)? Need to know what are the policy options on the table? (p. 3) Looking for locally rational policies that may result from program incentives, but may not work with overall system incentives (p. 6) Proposed to deliver "modeler feedback" insights at the end of the day (p. 6)	xli. Focused on procedure: Commissioner convenes meeting (p. 1); provide overview of 1st meeting (p. 1); draw primarily on "pluming" or "wiring"? (pp. 1 and 2); begin with "listing" or with "key" stocks (p. 2); prepare and rehearse "scripts" (p. 4-6); plan for the day (pp. 5 and 6); room set up and logistics (pp. 5-6)

Summary Tables 6-A: Best practices content in the March 13/14th meetings (R-06)

BPs Present	Problem definition	Model concept.	Total (By type)	BPs Absent	Problem definition	Model concept.	Total (By type)
Consensual	3	3	6	Consensual	2	0	2
Non-consensual	1	2	3	Non-consensual	1	1	2
Total (By step)	4	5	9	Total (By step)	3	1	4

Problem identification and definition, Consensual:
1) Problem
i. Rephrased the problem: limited employment capacity and "cycling" [recidivism] (pp. 2, 5, 6 and 14); loss of assistance (pp. 3, 6, 8, 10, 11 and 14)
2) Purpose
ii. Problem structuring: [SD is a flexible tool that allows us to structure and examine the problem together. This is how it works… I'll illustrate with an example…] (p. 1)
3) Dynamics
iii. Three-layer concept model constructed based upon desire to generate specific behavioral modes for clients "on assistance", "employed" and "unemployed and unsupported" [who lost assistance] (pp. 1 and 8)

Problem identification and definition, Non-consensual:
6) Prior experience
iv. Drew upon aspects of the final concept model for OMH-VESID workshop (p. 15)

Model conceptualization, Consensual:
8) Creativity and flexibility
v. Recognized [implicitly] that conceptualization is creative (p. 1)
9) Conceptual building blocks
vi. Proposed to use SD tools to engage the group in discussion (concept models, stock-and-flow diagrams, and graphs of behavior over time) (pp. 1-3, 5-6, 8, 10 and 11)
10) Key stocks
vii. "Maximum" three levels (p. 1)

Model conceptualization, Non-consensual:
12) Dynamic hypotheses (2)
viii. Drew upon hypothesized major causal loops determining the behavior of clients "on assistance", "employed" and "unemployed and unsupported" [who lost assistance], to conceptualize and formulate the models (pp. 1-3, 5-6, 8, 10-11, and 14)
13) Stock-and-flow
ix. Drew stock-and-flow structures depicting client flow and employment capacity (pp. 2-3, 5-6, and 10)

Summary Tables 6-B: MW&BO content in the March 13/14th meetings (R-06)

Problem identification and definition:	
Micro-world perspective:	Boundary-object perspective:
Problem:	
A) Preexisting x. Engaged in modeling a problem: loss of assistance (pp. 3, 6, 8, 10, 11 and 14)	
Purpose:	
C) Problem solving xi. Emphasized learning feedback-rich insights regarding problematic behaviors (pp. 3 and 6), and understanding the dynamic complexity of the problem (p. 8)	D) Consensus building xii. Emphasized client group ownership of the model (p. 1)
Synthesis:	
G) Dynamic hypothesis 1 xiii. Rephrased problem described by client group as limited employment capacity, "cycling" [recidivism], and loss of assistance (pp. 2-3, 5-6, 8, 10, 11 and 14)	

Model conceptualization:	
Micro-world perspective:	Boundary-object perspective:
Intrusiveness:	
J) Dynamic hypothesis 2 xiv. Drew upon hypothesized major causal loops determining the behavior of clients "on assistance", "employed" and "unemployed and unsupported" [who lost assistance], to conceptualize and formulate the models (pp. 1-3, 5-6, 8, 10-11, and 14)	K) Non-intrusive xv. Provided some structure to provoke and guide discussions, but avoided restraining conceptualization with framework: no attempt is made to "nail" the problem in the concept model [implicit] (p. 1)
Objectiveness:	
	M) Views/opinions xvi. Model is based in common knowledge and purposively incomplete (p. 1) [no attempt was made to ground the model in theories or facts; parameters were not estimated]
Boundary:	
N) Guided/parsimonious xvii. Focused conceptualization upon small number of stocks (p. 1) xviii. Pursued a parsimonious model including only dynamically relevant structures (p. 10)	O) Negotiated/broad xix. Lay the ground for facilitated negotiation of a shared view of the system: leave client group aching to fix the model, adding what they want to see in it (p. 1)
Role of the modeler:	
P) Reflector xx. Acted as teacher (p. 1): [SD is… This is how it works… I'll illustrate with an example…] xxi. Focused on insight (p. 1) xxii. Brought in an outside perspective: [loss of assistance increases with cycling, which in turn increases as more clients find jobs, all other things equal] (pp. 5-6)	

Summary Tables 7-A: Best practices content in the March 17/18th meeting (R-07)

BPs Present	Problem definition	Model concept.	Total (By type)	BPs Absent	Problem definition	Model concept.	Total (By type)
Consensual				Consensual			
Non-consensual				Non-consensual			
Total (By step)				Total (By step)			

Problem identification and definition, Consensual:
1) Problem i. The problems and issues were approached indirectly through questions like: How does the group think about the flow of clients through social services? (p. 10) What are the policies that we want to be able to test? (p. 11) What resources do you have to accomplish...? (p. 13) What resources control de flows? (p. 14) What are the driving forces for this resource...? (p. 15) What determines this resource...? (p. 24) ii. Gradually the group evolved toward examining the TANF and Safety Net programs (pp. 10-11), in terms of the possible increased burden at the county level (pp. 23 and 29) and the need for inter-organizational cooperation (pp. 17, and 30-31) iii. The modeler highlighted the apparent disconnect between client needs and availability of resources (p. 30) iv. Several unknowns and uncertainties were also identified (pp. 20, 26 and 31)
2) Purpose v. The purpose of the intervention was not directly stated, but a number of objectives were expressed: to test policy options (pp. 11-12), to align the community on what's needed (p. 17), to identify and examine uncertainties (p. 20), to build a shared view of the system (p. 21), and to build motivation to work together and collaborate (pp. 29-31). vi. Policy/Strategy exploration: Most prominent in this list was using the model to test policies under consideration or, alternatively stated, testing different strategies in terms of WR implementation to see which were more effective (pp. 11-12)
3) Dynamics vii. The dynamics depicted in the document are those produced by the concept models (pp. 6-9), and the raising work participation target, used as an exogenous input (p. 29)

Model conceptualization, Consensual:
8) Creativity and flexibility
viii. Avoided rigid separation of modeling steps: conceptualization and formulation were illustrated in an integrated form using concept models (pp. 5-9); problem definition and model conceptualization were addressed simultaneously using causal loops and stock-flow-diagrams (pp. 18-20 and 29-31); conceptualization and formulation were associated in social judgments (p. 28) used to derive a first set of numbers (values of stocks, inflows and resource utilization) ix. Approached conceptualization from different angles: a number of ways were used to elicit and illustrate information including idea generation using lists (p.11-12), inventories (p. 13) and driving forces (pp. 15-17 and 24-27), clustering (p.12 and 21-23), stock-and-flow diagrams (pp. 6-8, 10, 14, 15, 20, 21, 30 and 31), and causal-loop diagrams (pp. 14, 15, 18-20, 29-31)
9) Conceptual building blocks
x. Used concept models (pp. 6-9), stock-and-flow diagrams (pp. 10, 14, 20, 21 and 31) and causal-loop diagrams (pp. 14, 15, 18-20 and 29-31)
10) Key stocks
xi. Only three key stocks were used in the concept models (pp. 6-9). However, during elicitation, many stocks of clients (seven) and services/resources (nine) were identified (p. 21). Nevertheless, this total number of 16 stocks was reduced from the 23, listed during the first meeting on February 11. Variable names were nouns, and most of the units were specified (pp. 21-23)

Model conceptualization, Non-consensual:
11) Causal loops
xii. Used causal-loop diagrams to address capacities, constraints and reinforcing phenomena (pp. 14, 15, 18-20 and 29-31). This was done mostly in the back of the room, not with the group. Then, it was shown to the participants in the form of "modeler's feedback insights" at the end of each day (pp. 18-19 and 29-30). But, some drawings of causal links and closing of loops were done with the client group, during the elicitation process (pp. 14 and 15)
13) Stock-and-flow
xiii. These meetings placed great emphasis on the use of stock-and-flow structures. They were used in the concept models (pp. 6-9), and to elicit and depict the client-flow structure (pp. 10, 14, 20, 21 and 31)

Summary Tables 7-B: MW&BO content in the March 17/18th meeting (R-07)

Problem identification and definition:	
Micro-world perspective:	Boundary-object perspective:
	Problem: B) Messy xiv. Implicitly acknowledged that many issues were involved: A number of mingled "issues" were raised with the flow of conversation, in the form of policy options (pp. 11-12), (in)adequacy of resources, and internal and external constraints (pp. 14-17, 18-20, and 24-27). xv. Accepted broadly stated problem definitions: The modeler listened reflectively and created causal-loop and stock-and-flow diagrams (in the back of the room) depicting some of these issues. These diagrams were presented in the end of each day (pp. 18-20 and 29-31) xvi. Engaged in modeling the system: stock-and-flow structure and resource clusters (pp. 10, 14 and 21)
	Purpose: D) Consensus building xvii. Six clusters of policy options were formed from 29 disparate points (p. 12) xviii. The facilitator pursued agreement on a shared view of the system, in terms of the stock-and-flow structure and resource clusters (pp. 10, 14 and 21) xix. The meaning of variables was negotiated/defined and agreed upon (p. 23) xx. Emphasized consensus building: highlighting the motivation for participants to work together (pp. 29-31); proposing the alignment of the community behind a common agenda to deliver the services necessary to make welfare reform work (pp. 11, 12, 17, 20, 27, 30 and 31)

<table>
<tr><td colspan="2">Client/audience:</td></tr>
<tr><td>E) Monolithic

xxi. It appears as though the reflector sought common ground to pull the group together (pp. 29-31): a sense of preoccupation with the possible increased burden at the local level, and the benefits of cooperation between state and local levels of government, between local government agencies, and between public and private sectors</td><td>F) Constituencies

xxii. The list of participants of this pair of meetings reflects a diverse client group, involving multiple organizations, both public and private, and two levels of government (local and state) (p. 4)
xxiii. The list of policy options (p. 11) is a reflection of what the group wants to accomplish. Different options were clustered into six policy areas of concern (p.12). No one specific policy domain was embraced as the key area to focus the intervention. These different concerns were welcomed and appreciated. For each policy domain, a number of concerns were raised (pp. 13, 15-17, 21-23 and 24-27)</td></tr>
<tr><td colspan="2">Synthesis:</td></tr>
<tr><td>G) Dynamic hypothesis 1

xxiv.</td><td>H) None

xxv. Defined problem/purpose broadly: the reflector sought to synthesize the issues as a possible increased burden at the local level with reform (pp. 29 and 31), and a disconnect between needs and resources (pp. 30 and 31), suggesting the benefits of cooperation between state and local levels of government (pp. 30 and 31), between local government agencies (p. 29), and between public and private sectors (pp. 30)
xxvi. Discussed structure uncoupled from behavior: the conceptualization of stock-and-flow structures (pp. 10, 14, 15, 20, 21, 30 and 31) and causal-loop diagrams (pp. 18-19 and 29-30) were done without the use of reference modes</td></tr>
</table>

Model conceptualization:	
Micro-world perspective:	Boundary-object perspective:
Intrusiveness:	
J) Dynamic hypothesis 2	K) Non-intrusive
xxvii.	xxviii. Provided some structure to provoke and guide discussions, but avoided restraining conceptualization with framework: used concept models to instigate discussion but didn't built upon it in elicitation (pp. 6-9); in many cases issues were discussed using simply lists, without any graphical representation (pp. 11-12, 16, 17, 24-27) xxix. Changed lenses: a number of ways to elicit and illustrate information were used, including idea generation using lists (p.11-12), inventories (p. 13) and driving forces (pp. 15-17 and 24-27), clustering (p.12 and 21-23), stock-and-flow diagrams (pp. 10, 14, 15, 20, 21, 30 and 31), and causal-loop diagrams (pp. 14, 15, 18-20, 29-31) xxx. Adopted inductive, bottom-up approach: client-flow structure building (pp. 10, 14 and 21), policy options clustering (pp.11-12), modeler's feedback insights revealed later (pp. 18-20 and 29-31), and resources clustering (pp. 21-23)
Objectiveness:	
L) Theories/facts	M) Views/opinions
xxxi.	xxxii. Elicited views and opinions: the clients' views and opinions were used to derive information about stock-and-flow structures (pp. 10, 14 and 21), policy options (pp. 11-12), resources available (pp.13 and 21-23), and processes and mechanisms for moving clients around and reallocating resources (pp. 15-17, 18-20, 24-27 and 29-31) xxxiii. Used social judgments as data: thirty-eight "questimates" (of current values of stocks and flows, and resource utilization) representing the state of the system were elicited from the participants using personal judgments (pp. 28), drawing upon the client-flow structure with the clustered resources (p. 21)

Boundary:

N) Guided/parsimonious	O) Negotiated/broad
xxxiv.	xxxv. Conceptualized using a large number of stocks: many stocks of clients (seven) and services/resources (nine) were identified (p. 21) xxxvi. Struggled with level of aggregation and scope issues: struggled with level of aggregation, separating high and low need families, and families in diversion (pp. 14 and 15); struggled with the scope of the model and pursued a broad boundary (pp. 16-17 and 24-27) xxxvii. Facilitated the negotiation of a shared-view of the system: facilitated the negotiation of a shared-view of the client-flow structure of the system (pp. 10, 14 and 21); facilitated the process of clustering policy options (p.12) -a shared-view of the policy domains, and of clustering resources available (pp. 21-23); pursued agreements and shared definitions on variables (p. 23)

Role of the modeler:

P) Reflector	R) Facilitator
xxxviii. Acted as a teacher: concept models (pp. 5-9) xxxix. Brought in an outside perspective with the modeler's feedback insights focused on the content of what was said during the meeting (pp. 15, 18-20 and 29-31) xl. Focused primarily on insight:	xli. Acted as facilitator and learner: client-flow structure (pp. 10, 14 and 21); policy options (pp. 11-12); resource inventory (pp. 13 and 21-23); determinants, capacities and constraints (pp. 15-17 and 24-27)

APPENDIX 7 – INTERPRETIVE DIALOGUE FOR RECORD 1 (PROJECT PROPOSAL)

Moderator – Let's begin our discussion of this project with a general introduction based upon the project proposal (R-01). Allow me to summarize the result of our panel's analysis on the "best practices" content of this document, and to highlight some of the key elements of this case, as specified in this draft of the contract:

As synthesized in Summary Table 1-A, our panel has found evidence in this document related to three out of the thirteen "highest rated" best practices (#2-purpose, #6-prior experience and #7-generic model). The proposal discussed the purposes of this modeling effort, which were: to assist three local social services districts to plan for changes resulting from welfare reform, developing county-specific models capable of addressing "what-if" policy questions concerning implementation options, each serving as a county-specific representation of its human services delivery systems (items i through iv); and to generalize from these county-specific models to other sites, by developing a flight simulator that would be useful to non-participating counties, in their welfare reform planning and implementation decisions (items v and vii). It was highlighted in the proposal that the modeling team had detailed and deep understanding of issues related to human services delivery systems, and extensive experience in developing system dynamics models in this domain of knowledge and practice (item vi).

Also, I would like to highlight that:

viii. The schedule (time line) indicated a total of 24 weeks, or six months, to complete all elements of this project, with each county-specific model requiring approximately eight weeks to be completed (pp. 2 and 7); and
ix. The proposed budget to execute this project was of about one hundred thousand dollars (p. 8).

I am interested in the perspectives of our two panelists on these and other items of this document. (Based upon their opposing views, we have also compiled their coding of the content of the document in Summary Table 1-B. They've been instructed to refer to the results presented in these summary tables as they present their arguments.)

Let's start our discussion with Ms. MW's point of view on this document:

Ms. MW – I have the following observations to make:

- I think this document was mostly about the purpose of this intervention (items i to v, and item vii). However, what is intriguing to me is that:

  xxii. There was no discussion about the problem to be modeled!

- What was wrong that motivated this work? Whatever it was, this document did not seem to address it.

- Yet, this was probably a problem solving intervention, I think, because they discussed the importance of understanding (item xi), and of being able to frame the lessons learned for the purpose of follow-up training at other sites (item xix). Moreover, the modeling team promised to act as analysts, based upon their expertise (items vi and xviii). Besides, as Sterman (2000) would say, we develop models to solve particular problems, not to model the system (p. 79).
- Therefore, ***I feel that the most important piece of information missing from the project proposal is a problem statement***. I would have liked to see them address in this proposal the micro-world issue noted by Forrester (1961), that a model should be designed to answer a specific, tangible and meaningful question, or set of questions (p. 449). If they did that, I didn't see it.

  xxi. In fact, ***I would have liked to see graphs of the problematic behaviors over time***.

- Was there a dynamic problem? From my reading of this document, I really couldn't say.

Mr. BO – Those are interesting points, but you have to read carefully to see the issues surfacing from within. Clearly there were some issues on the table:

- Their motivations seemed to be related to *change*! These changes were being "imposed" upon the local districts (item i). This was bound to create some problems for them.
- Also, the State wanted to find out how the locals were going to react to these changes. This is probably why there would be three county-specific models (item ii). Each county would be able to address whatever issues they were most concerned with (item iii) and, most importantly, be able to experiment with whatever solutions they had in mind to tackle these problems (item iv).
- ***It looks to me like they were going to gradually arrive at a problem statement, in a process of socially constructing the problem*** (item x). In fact, they brought a lot of people on board, in a participatory group process involving the county's major stakeholders in the human services delivery system (item xiv), ***to address what could be a "messy problem"*** (Ackoff, 1974). These were the very people who were affected by these changes, and they would be the ones negotiating problem definition, and giving shape to the models (items xvi and xvii). Thus, the representation of the county's human services delivery system (and its boundary) would be articulated and integrated by the group members themselves, based upon their different perspectives (item xv and xvii). Clearly, the modeling team was concerned with ownership (item xiii) –as much as with understanding, as already noted by Ms. MW.
- I think the major role of the modeling team would be to facilitate this process and conversation (items xx and xxi) –more than to act as consultants and educators, as noted by Ms. MW. After all, they would be working with a large and diverse group involving different levels of government (state and local), executive agencies (social services, health and aging), branches of government (county

legislature), and also nonprofits. It would be a challenging task to get such a diverse group to see the problem from a single perspective. In fact, as Vennix (1996) would argue, the participants might not even agree that there was a problem, much less what it was (p. 13). For instance, some participants would see reform (change) to be a solution, and not a problem. This may be the very reason for the absence of a narrow problem statement in this document. Such a statement could actually reduce the participants' interest in engaging in the intervention.

- This may also be the reason why the purpose was broadly defined, from building a representation of the system to strategic planning (item xii), as opposed to problem solving.

Ms. MW – I am not entirely happy with this line of reasoning, because I don't believe we can build a model of a system and have something insightful to say afterwards. The model boundary, in my view, should be guided by the problem statement and by the dynamic hypotheses generated to explain problematic behaviors, and not by inter-group negotiation.

Moderator – As expected, given that our panelists are taking ideal-type extreme positions, we have a disagreement. But I interrupt this argument to avoid the Straw Men Fallacy and, instead, propose a partial synthesis.[20]

From the analysis of this first document, ***it appears as though this intervention weighed in favor of the boundary-object perspective*** (see Summary Table 1-B). It looks as if the modeling team set out to model "the system" as opposed to a "preexisting" problem. The intervention involved multiple stakeholders or constituencies, and it had purposes other than problem solving, including satisfying the needs of at least three audiences (participating counties, the State, and non-participating counties), not to mention the expectations of the other non-DSS participants (other agencies, nonprofits, etc.). ***Mr. BO is suggesting that negotiating problem definition (i.e., socially constructing the problem) and collectively delineating model boundary, are legitimate functions of GMB, particularly when dealing with messy problems***. This situation calls for an emphasis on facilitation in the role of the modeler, as opposed to reflection.

On the other hand, ***Ms. MW is not convinced that this will result in an insightful model, and called for a more explicit problem statement, including reference modes of problematic behaviors***.

Participant, can you provide our panel with clarification on any of these issues?

[20] This discussion is different from a Straw Men argument in the sense that each panelist is asked to take an extreme position, as opposed to distort the other panelist's position to the extreme: "The Straw Man fallacy is committed when a person simply ignores a person's actual position and substitutes a distorted, exaggerated or misrepresented version of that position" (http://www.nizkor.org/features/fallacies/straw-man.html). Nevertheless, these extreme positions are ideal-types that do not actually exist. Instead, they are simply caricatures that serve the purpose of revealing points of tension in pursuing both "insight" and "consensus". They provide the lenses to look for competing (or expected, but missing) pieces of evidence in the documentation, and to tease an interesting and constructive argument.

Participant – Unfortunately I will not be very helpful with respect to project negotiation and design. I was not a participant of this contractual phase of the project. Therefore, ***I am not sure why this document does not contain a discussion of the potential issues surrounding welfare reform***. It may be for the reason indicated by Mr. BO, or simply because one was not required at the time by the paying client. Maybe this was discussed verbally, but not specified in the proposal. ***Personally, I would have liked to see such a discussion in this document, including reference modes depicting the problematic dynamics in the system, or the anticipated issues due to welfare reform (items 1 and 3 of the best practices framework)***.[21]

Otherwise, I think it was OK to have such a flexible agenda at this point to deal with a diverse group of stakeholders and, in retrospect, what I think qualifies as a messy problem. Therefore, I believe that setting out to build a boundary-object with this group (even if it meant modeling the system as opposed to a problem) was a good starting point to investigate their concerns. Thus, ***I am comfortable with the bias presented in this document, pointing in the direction of working with the groups toward developing a shared-view of system and, in the process, building consensus on the problematic issues and alternative lines of action***.

A final comment that I would like to make is that ***the proposal grossly underestimated the level of effort necessary to carry out this project, both in terms of time and financial resources***. Actual implementation took nearly four times longer (22 months). Also, a supplementary budget was requested and approved. ***I attribute this to the open-ended nature of the scope of work (in terms of both model purpose and problem), and to the difficulty in bringing closure to a system dynamics modeling effort, particularly when model ownership is shared with a diverse clientele***. Furthermore, I expect this to be a common issue in GMB interventions, and maybe in SD interventions in general.

One can either predefine a process and level of effort, and stick to it, whatever the product, or incrementally change the process and increase the level of effort, in order to devote time and energy to unforeseen needs or demands, thus concentrating on the quality of the product and the satisfaction of the clients. The iterative nature of SD modeling, and the fact that one can always find something to be improved in the model, its applicability expanded, or its detail complexity synthesized, lends the effort potentially to a non-conclusive deliverable.

[21] In the process of being involved in this work, I came to identify the major issues as being related to uncertainty among the parties as to the outcomes of reform, especially with respect to client well-being and the financial consequences of loss of eligibility on TANF after five years –which was one of the major features of the reform.

APPENDIX 8 – CODING RULES FOR BEST PRACTICES IN SYSTEM DYNAMICS
(Adapted from Martínez-Moyano and Richardson, 2002 –*original in italics and bullets*)

Problem identification and definition, Consensual:
1) Problem descriptions were sought – Asked questions regarding problems/issues; listened to understand the clients' problems/issues; rephrased the problems/issues. ❖ *Make sure you understand the clients problems or ideas by talking and listening carefully to what the client has to say* ▪ *Listen carefully to client stories* ▪ *Let most senior client say "what brought us together"* ▪ *Talk and listen reflectively to problem owners (clients)* ▪ *Make sure you understand the client's problem* ▪ *Ask client sufficient questions –avoid giving premature answers* ▪ *Check whether (dis)agreement on problem exists (when you are working with more than one person)*
2) The purpose(s) of the modeling effort were discussed – Defined the purpose(s) of the modeling effort (e.g. problem structuring, problem solving, system's redesign, policy/strategy exploration, consensus building, etc.). ❖ *Define the purpose of the modeling effort (e.g. strategy/policy, theory building, education, and training* ▪ *Clarify purpose (e.g. strategy/policy, theory building, education, training)*
3) Dynamics were depicted – Identified key variables of interest and drew reference modes of behavior, historical (actual or hypothesized) or expected (future projection). ❖ *Identify reference modes of central processes to be studied. Also, use reference mode diagrams to explore people's expectations of future behavior* ▪ *Dynamic thinking –drawing graphs over time* ▪ *Have client draw about 5 to 7 reference modes* ▪ *Use reference mode diagrams to explore many people's expectations of future behavior* ▪ *Identify the reference mode: the central "process" or time development to be studied* ▪ *Develop history of key measures* ▪ *Sketch a graph of the time behavior of the supposed problem* ▪ *Observe the behavior of key variables of interest over time* ▪ *Select subgroup of time histories with simpler patterns to represent behavior of interest* ▪ *Draw reference modes of behavior* ▪ *Plot time histories of whatever is available*
4) Causal stories were sought – Asked what caused or is causing the behavior of key variables. ❖ *Ask why is current behavior of key variables generated, and what is causing it* ▪ *Ask why is current behavior of key variables generated, and what is causing it*
5) Dynamic hypotheses (1) were used to discuss behaviors – Rephrased causal stories as "this behavior is caused by that structure." ❖ *Formulate the dynamic hypothesis (i.e. "this behavior is caused by that structure"* ▪ *Formulate the dynamic hypothesis (i.e., "this behavior is caused by that structure")*

Problem identification and definition, Non-consensual:
6) Prior experience was associated to the modeling effort – Identified the class of systems to which the particular case belonged. ❖ *Identify the class of systems to which the particular case under study belongs* ▪ *Identify the class of systems to which the particular case belongs*
7) A generic model approach was suggested – Modeled (proposed modeling) the class to which the case belonged; de-emphasized the detail complexity of the case at hand. ❖ *Model the class to which the case belongs, not the case at hand* ▪ *Model the class to which the case belongs, not the case at hand*

APPENDIX 8 – CODING RULES FOR BEST PRACTICES IN SYSTEM DYNAMICS **(CONTINUED)**

Model conceptualization, Consensual:
8) Creativity and flexibility were employed – Approached conceptualization from different angles; avoided rigid separation of modeling steps (problem identification/definition, model conceptualization, formulation, etc.); recognized that conceptualization is creative (there are no recipes). ❖ *Recognize that conceptualization is creative and needs to be approached from different angles* ▪ *Avoid rigid separation of identification, conceptualization, and formalization stages* ▪ *Approach conceptualization from different angles like a new creation* ▪ *Recognize that conceptualization is creative –there are no recipes*
9) Conceptual building blocks were used to elicit mental models – Used SD tools (such as graphs of behavior over time, concept models, feedback loop diagrams, or stock-and-flow diagrams) to reveal the participants' mental models or engage the group in discussion. ❖ *Generate a dialogue with the client group to address their mental models and the dynamic hypothesis* ▪ *Discuss the dynamic hypothesis with a study team* ▪ *Engage in conversation around conceptual building blocks* ▪ *Elicit client's mental models*
10) Key stocks were used to focus conceptualization – Identified critical variables that characterize the state of the system. ❖ *Identify the major stock variables that describe the system and make sure their names are nouns, not verbs or action phrases* ▪ *Identify levels (states) first to describe system with and without symptoms of interest* ▪ *Identify the few (critical) main system variables (normally levels; 1-3)* ▪ *Select stock variables in reference mode* ▪ *Make sure stock variable names are nouns, not verbs or action phrases* ▪ *Select one key stock variable in a single conserved system if more than one variable is present* ▪ *Write names of selected stock variables with space between them to draw perceived causal links* ▪ *Start with major stock variables, try to impose your feedback loops* ▪ *Identify "essential" asset stock accumulations*

Model conceptualization, Non-consensual:
11) Causal loops were sketched – Drew closed-loop diagrams around key variables. ❖ *Identify (draw) causal-loops iteratively, and then identify state variables and system boundary*
12) Dynamic hypotheses (2) were crafted to guide formulation – Hypothesized major causal loops determining the behavior of the key variables. ❖ *Identify (draw) causal loops determining behavior over time of the main variables* ▪ *Create comprehensive set of dynamic hypotheses (loop explanations for reference modes)* ▪ *Identify loops and develop initial dynamic hypothesis* ▪ *Identify major causal loops determining development over time of the main variables* ▪ *Draw the structure of your dynamic hypothesis as a causal diagram* ▪ *Form dynamic hypothesis before modeling to depict major feedback loops across sectors* ▪ *Draw causal loop diagrams if stock-and-flow structure presents difficulties* ▪ *Identify feedback loops* ▪ *Look for a few potentially important feedback loops* ▪ *Concentrate first on main connections and major loops*
13) Stock-and-flow structures were sketched – Drew structures depicting accumulations (e.g. resources, customers, products or services); identified influences on flows. ❖ *Identify (draw) stock-and-flow structures (resources, customers, products and services) and then identify influences on flows* ▪ *Identify (draw) stock-and-flow structures (resources, customers, products and services)* ▪ *Identify influences on flows*

Back to the Top