Teamwork in Group Model Building[1]

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Abstract
Ongoing research in the Rockefeller College of Public Affairs and Policy is focusing on strategies for efficient and effective model building in groups. The intent is to involve a relatively large client group in the business of model formulation, not just conceptualization. Recent projects have explored strategies for accelerated group model building in the context of three public policy problem areas: the burgeoning cost and caseload of foster care in New York State, recent unexplained increases in Medicaid costs in the state of Vermont, and homelessness policy initiatives in New York City.

Five roles appear to be essential to support effective group model building efforts. We term the five roles the *facilitator*, the *modeler/reflector*, the *process coach*, the *recorder*, and the *gatekeeper*. This article identifies the five roles, briefly overviews the three problem areas, sketches the design of the group model building efforts, outlines the apparent results, and hypothesizes principles and strategies to guide future group modeling efforts.

Introduction

Ongoing research in the Rockefeller College of Public Affairs and Policy is focusing on strategies for efficient and effective model building in groups. The work is related to efforts by Richmond (1987), Vennix (1990), and Morecroft (1991), and grows out of more than fifteen years of research on computer-aided, facilitated meetings.[2]

Group model building, as we intend the phrase, signals the intent to involve a relatively large client group in the business of model formulation, not just conceptualization. The goals are a wider resource base for insightful model structure, extended group ownership of the formal model and its implications, and acceleration of the process of model building for group decision support. However, the pitfalls generated by group processes and the modeling process are formidable.

It appears that no fewer than five roles or functions are essential to support effective group model building efforts. We term the five roles the *facilitator*, the *modeler/reflector*, the *process coach*, the *recorder*, and the *gatekeeper*. Many of us have tried to make do with one or two individuals handling these five roles (usually unconsciously), but our experiences with large modeling groups struggling with weighty problems involving diffuse knowledge suggest the roles are often best handled by separate individuals.

Ideas for the importance of these roles grew out of the group process literature,[3] the system dynamics literature,[4] and experiences of the Decision Tectronics Group at the University at Albany,[5] including work done in 1987 and '88 for the New York State Insurance Department on medical malpractice insurance regulatory policy.[6] Recent projects at the Rockefeller College have explored strategies for accelerated group model building involving these five roles. The explorations have been carried out in the context of three public policy problem areas: the burgeoning cost and caseload of foster care in New York State, recent unexplained increases in Medicaid costs in the state of Vermont, and homelessness policy initiatives in New York City.

The Five Roles

The initial modeling motivation.

In work done for the New York State Insurance Department in 1987 and 1988, one of the authors (Richardson) experienced some difficulties working with a five-member model reference group in preparation for two two-day decision conferences on malpractice insurance regulatory policy. Reflecting on the difficulties, we hypothesized that they stemmed from the multiple roles the modeler was trying to

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2 See, e.g., Milter and Rohrbaugh (1985), Phillips (1988), Carper and Bresnick (1989), Rohrbaugh (1992), and Vari and Vecsenyi (1992). See Vennix et al. (1992) for further references.

3 The earliest group process literature contains descriptions of numerous leadership roles that must be assumed in order for groups to be effective (Benne and Sheats 1948). Recent developments in the definition of facilitator roles have helped to clarify how group leadership can be provided by both internals and externals (Schein 1987, Kayser 1990, Friend and Hickling 1987).

4 Hints of multiple roles in modeling with groups appear in Stenberg (1980) and Vennix (1990). Roberts (1977) emphasizes rapid development of an initial model, maximum in-house participation, and the importance of the role we have termed the gatekeeper. We take the "gatekeeper" term from the R&D literature (Allen 1970).

5 See Milter and Rohrbaugh (1988); Mumpower, Schuman, and Zumbolo (1988); McCartt and Rohrbaugh (1989); and Schuman and Rohrbaugh (1991).

6 See Richardson and Senge (1989) and Reagan-Cirincione et al. (1991).

fill. The modeling tasks involved drawing out information from the reference group and about the structure and behavior of the problem, formulating that information in a model, presenting and explaining that model formulation back to the reference group, eliciting their reactions for model corrections and refinements, and carrying out the necessary revisions and extensions. All the while, the modeler had to function simultaneously as an enlightened group process coordinator, knowledge elicitor, group facilitator, and system dynamics educator.

The modeler had the advantage of carrying out these meetings in the context of the work of the Decision Tectronics Group. As a result, he knew of the importance of a second person who could focus on recording information so the modeler/consultant could be saved that task, but nonetheless, the rest was too much. The modeler/ consultant found he could not focus on all the necessary group tasks at the same time: His modeler/explainer/educator roles became confused with, and sometimes even contradicted, his roles as knowledge elicitor and group process facilitator. We modelers might have missed or ignored the confusions, as we and other modelers have in the past, but DTG decided to conduct our next meeting with an experienced group facilitator, and a much more powerful way of handling group model building discussions was revealed.

Five roles in group model building

This more powerful way involves explicitly separating the distinct roles involved in the group model building process. Following further experiments with group model building efforts, which are described in the subsequent sections of this paper, we have identified what we believe are five essential roles. The people who fulfill these roles form the basis for an effective *group modeling support team:*

The *facilitator:* functions as group facilitator and knowledge elicitor. This person pays constant attention to group process, the roles of individuals in the group, and the business of drawing out knowledge and insights from the group. This role is the most visible of the five roles, constantly working with the group to further the model building effort.

The *modeler/reflector:* focuses not at all on group process but rather on the model that is being explicitly (and sometimes implicitly) formulated by the facilitator and the group. The modeler/reflector serves both the facilitator and the group. This person thinks and sketches on his or her own, reflects information back to the group, restructures formulations, exposes unstated assumptions that need to be explicit, and, in general, serves to crystallize important aspects of structure and behavior. Both the facilitator and the modeler/reflector in our experiments have been experienced system dynamics modelers.

The *process coach:* a person who focuses not at all on content but rather on the dynamics of individuals and subgroups within the group. It has been both useful and annoying that our process coach is not a system dynamics modeler; such a person can observe unwanted impacts of jargon in word and icon missed by people closer to the field. The process coach in our experiments has tended to serve the facilitator; his efforts have been largely invisible to the client group.

The *recorder:* strives to write down or sketch the important parts of the group proceedings. Together with the notes of the modeler/reflector and the transparencies or notes of the facilitator, the text and drawings made by the recorder should allow a reconstruction of the thinking of the group. This person must be experienced enough as a modeler to know what to record and what to ignore.

The *gatekeeper:* a person within, or related to, the client group who carries internal responsibility for the project, usually initiates it, helps frame the problem, identifies the appropriate participants, works with the modeling support team to structure the sessions, and participates as a member of the group. The gatekeeper is an advocate in two directions: within the client organization he or she speaks for the modeling process, and with the modeling support team he or she speaks for the client group and the problem. The locus of the gatekeeper in the client organization will significantly influence the process and the impact of the results.

We hypothesize that some of these five roles may be combined, or distributed among the consultants and the clients in a group model building project, but that all five roles or functions must be present for effective group support. We further hypothesize that group modeling efforts can be significantly accelerated by explicitly recognizing the five roles and deliberately assigning them to different skilled practitioners.

The Cases

Foster care.

In 1990 system dynamics practitioners at the Rockefeller College were approached by the Department of Social Services (DSS) in New York State to explore the potential of simulation modeling to aid understandings of the structure and dynamics of foster care populations. Traditionally a small and placid part of the New York State budget, foster care began to grow dramatically after 1985, owing, it is thought, to the emergence of the crack cocaine epidemic. Nationally known for the creation and analyses of extremely detailed data bases of foster care in several states, our contact at DSS had two interests: contributing to solutions of the problems generated by rapid growth in the need for foster care in New York City and elsewhere, and experimenting with nonlinear simulation modeling to reveal structural foundations for complex dynamics. Some extremely detailed modeling work, showing the ability to match the DSS data, was pursued at the Rockefeller College to the point of reports and recommendations to the Commissioner of Social Services (Wulczyn 1990a, 1990b).

To further the effort, we became interested in exploring an *accelerated* group modeling effort that had as its core idea the separation of three primary roles that had seemed significant in the medical malpractice work: a group facilitator/elicitor, a modeler, and a recorder. Our contact at DSS assembled a group of experts in foster care willing to spend two days experimenting with a simulation modeling approach largely unfamiliar to them.

The two-day workshop began with the sketching of a simple *concept model* of the foster care system (Figure 1). The concept model served three purposes. First, it was the medium for teaching the stock, flow, and causal link icons to be used throughout the workshop. Second, the concept model was used to demonstrate there are links between structure and dynamic behavior. The model was simulated three times, showing the effects of successively closing negative feedback loops (indicated by the dotted structures shown in Figure 1), striving to control the foster care caseload. The first run, without either of the controlling loops, showed unconstrained exponential growth in the child populations. Figure 2 shows the dynamics of the second run, in which the screening policy loop was activated, reducing the inflow to kids in care when the stock begins to exceed the care capacity. Third, and perhaps most important, the concept model served to initiate discussion about the structure and behavior of the real system. The model looked enough like the foster care system to be immediately familiar to the participants, but it was agonizingly inadequate, and discussion of how to improve it began immediately.[7]

The facilitator/elicitor then took over, and the group began discussing dynamics and the stocks and flows of children in the foster care system. Large white boards were used to sketch diagrams; standard white flip charts stored important ideas; notes were kept on a computer by a recorder; and the modeler/reflector, as refiner of model structure, sketched and formulated and reformulated on paper, periodically taking over the discussion to work with the group about what he heard them saying.

The group evolved the view of stocks and flows of children in the foster care system shown in Figure 3. By dinner time on the first day of the workshop, the rudiments of a model formulation involving four sectors had been crafted by the group and the modeling support team: Child stocks and flows, Child Protective Services staff and Case workers, Care capacities, and Workload effects. The modeler/reflector spent the evening after dinner translating the model into STELLA[8] while the facilitator worked with the group to assign values to parameters, initial values, and initial flows (which proved surprisingly helpful). The next morning, after a session stepping back to review the definition of the problems being addressed, the model was simulated for the group.

The workshop was considered a great success by all the participants, with the modeling team flushed with enthusiasm about developing a significant model with the active participation of twelve experts in under two days. Yet little obvious follow-up work resulted until a year later, when modeling support team worked with a group of foster care agency heads in New York City in a similar but much abbreviated fashion to set a base for understandings about the implementation of an initiative in New York State foster care known as Home Rebuilders. This experimental program will alter funding mechanisms in an effort to focus resources on *after care*, an idea that was supported by model-based analyses from the foster care modeling work.

Medicaid in Vermont.

Prior to 1990 Medicaid costs in Vermont had been reasonably predictable. Although rising, costs were sufficiently well-behaved to allow the department’s traditional approaches to anticipate and budget for next year’s costs well. But in 1990, Vermont’s Department of Social Welfare, the state's designated Medicaid agency, part of its Agency of Human Services, was forced to go back the Legislature several times in the space of six months to request budget adjustments to cover dramatic unanticipated increases in costs. Concern about the traditional approaches led to the opportunity to try to introduce systems thinking and simulation into the workings of the Agency of Human Services. The new head of the Agency approached a colleague who had been involved extensively since 1982 using system dynamics

7 Concept models, as we use the term, are different from the small but complete models of the sort described by Randers (1980). Instead, they are preliminary models. Because they must be very simple visually and contain nothing but friendly algebra, they are typically rather bad first cuts at system dynamics models. Initially, they are mostly open loop and are constructed to hide as much diagrammatic complexity as possible by eliminating parameter icons and being clever (but clear) in equation formulation. Yet they must lead the group in the direction of robust and appropriate formulations for the problem at hand. See the final section of this paper for the special considerations involved in formulating concept models.

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modeling and simulation to forecast Vermont's electrical energy demand and supply. The Agency head wanted to approach the Medicaid cost problem in particular, and Vermont human service planning in general, more systematically, although he had a diffuse notion of what that meant, more in the vein of the MIS/program budgeting approach (e.g., Churchman 1968) than system dynamics. The Vermont energy modeler held several small group sessions with Agency management, presenting STELLA and discussing the systems approach.

Vermont then contacted system dynamics practitioners at the Rockefeller College to see if they knew of work on Medicaid in the system dynamics literature. Fresh from the foster care work, we were interested in trying again to engage a large group in the modeling process, so a series of group model building workshops were set up as a part of a project to model the Medicaid cost problem.

The Medicaid problem is a significant one and had high visibility in the Vermont Agency of Human Services, so there were a number of groups of players who needed to be involved. Our Vermont contact identified

Stake holders: Agency and department heads with significant responsibility for Medicaid program or financial management in the state, members of the Governor's staff, and an invited outsider from the National Governor's Association;

Experts: a group of people within the Vermont Agency of Human Services (including some stake holders) who are most knowledgeable about the Medicaid system in Vermont, together with some members of key health care policy groups outside AHS;

The Core Modeling Group: a small group of people who would directly support the model building efforts with data and analyses and who could be expected to carry on the simulation work after the initial group work was completed.

He assembled lists of people in these categories, developed their interest, taught many of them something of the system dynamics approach, and enrolled them in the project.

With its visibility and potential political importance, the project became larger than the experimental work with the foster care model group. The modeling team was reluctant to enter two days of workshops with all three groups, including the important Stake holders, without a warm-up group model-building workshop or rehearsal. So we carried out a sequence of group model building workshops, in which the first and third involved the Expert and Core subgroups in the most modeling intensive parts of the project:

May 28, 1991: Expert and core group modeling workshop
June 27-28: Stake holders, expert, & core group modeling workshop
July 16: Expert and core group model revisions workshop

As in the foster care workshop, the May and June Vermont Medicaid workshops both began with a concept model, diagramed in Figure 4. The base run of this concept model (Figure 5) is driven by small increases in unemployment, Federally mandated eligibility for Medicaid, and annual cost per user. The resulting sharp rise in Vermont Medicaid expenditures exhibited by the model reflected the recent Vermont experience.

The intended adequacies and inadequacies of the concept model immediately stimulated discussion, which led in the first workshop to the model diagramed in Figure 6. The obvious malleability of the models, and their partial fit to the mental models of the participants, led to a laundry list of concepts and variables the group wished to see incorporated into a full model useful for forecasting and policy.

The second of the three workshops was attended by all three groups, Stake holders, Experts, and the Core group. The interaction proceeded as in the previous group model building workshops, but a working model did not result. Modeling proceeded after the workshop in the more traditional way (behind the scenes), and the third workshop used the five-role scheme (without the process coach) to review, critique, and revise the model.[9] In this last workshop, the modeler/reflector acted not as a master modeler but more as a reflector on the group's discussion, a "contemplator" whose job was to refine and crystallize the thinking of the group. We came to understand that the role of the modeler/reflector is more general than "modeler," and that there is great value to having a person reflecting on the group's thinking and reflecting it back to them.

Homelessness in New York City

Our most recent experience with these ideas in a group model building workshop occurred at the invitation of a team of modelers in the Operations Research Unit of the New York City Office of Management and Budget. The team had experimented with an iThink™ model intended to help forecast needs for resources to deal with the growing homelessness problem in the city, and they sought support in carrying out a two-day model refinement workshop involving homelessness service providers and policy makers.

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9 Following the sequence of workshops, the Vermont team continued development of the modeling work, and a member of the Albany team pursued in parallel a model-based study of national health care finance policy (Ratanawijitrasin 1992) which was awarded the 1992 dissertation prize of the National Association of Schools of Public Administration and Affairs (NASPAA).

The workshop was usual in that many of the participants had seen elements of OMB's model. It began with a sequence of two concept models. The first was a simple aging chain of three levels representing homeless families, homeless families in shelters, and homeless families in housing. The second concept model, shown in Figure 7, built on the first and added flows from the sheltered and housed populations back into homelessness. Although we had prepared the second model in advance, these recidivist flows were elicited from the participants to involve them in the process of model conceptualization, formulation , and revision. As in the group model building sessions described earlier, the models were simulated and altered a bit, to emphasize the roles of formal models in understanding structure and dynamics and to emphasize the malleability of the formal model. Here the "Crisis incidence" fraction (a table function of time) was increased for a short period to simulate a bulge in the flow of homeless families into shelters. The resulting unsurprising population dynamics are shown in Figure 8.

At this point in the workshop, the OMB team took over and presented the structure and behavior of their model. It was far more detailed and accurate in its disaggregation of families in various stages of the homelessness service system. Most of the morning of the first day was spent understanding the structure and dynamics of this complex view of the stocks and flows of homeless families in the current and proposed New York City homelessness services system. Yet it too lacked a crucial set of policy variables — the *capacities* of the system (people and beds) to handle the homeless family caseload.

By prior agreement with the OMB team, we began the afternoon session with a another addition to the simple concept model — shelter capacity and housing capacity, both thought of as a number of families that could be handled. The capacities were linked to the families in the system simply by ratios, the shelter density and the housing density (see Figure 9, ignoring the gray elements for the moment). We showed the group the previous simulation run (Figure 8) and displayed the graphs of the density ratios, which rose dramatically beyond acceptable or sustainable levels. We then asked the group what pressures these densities would generate if they approached or exceeded one. That question, repeated in many contexts as the workshop continued, proved incredibly productive, for it leads naturally to the closing of feedback loops and the subsequent identification of circular causal processes important in the system.

Here the group suggested that rising population densities would shorten the average length of stay in shelters (to speed families out and make room for the growing inflow) and would decrease the fraction of the shelter outflow that could move into permanent housing (because there would be no room in housing for the increased flow). We sketched the structures shown in figure 9 on a white board, motivated the necessary equation formulations, and then simulated the model (which we had prepared in advance). Figure 10 shows the rather complex dynamics that result from the interactions of these stock-and-flow feedback structures.

The remainder of the first day and all of the second day were devoted to exploring in detail the capacities in the system judged by the group to be crucial for the policy modeling effort. Staff and bed capacities in all sectors of the detailed OMB model were identified, diagramed one at a time, and linked to the rest of the sector. Figure 11 shows a typical diagram sketched in front of the group in response to suggestions of the group, here capturing homeless families in the income support unit and the assessment process. The figure shows the beginnings of a number of feedback loops stimulated by considering the load or density ratios of families in these units relative to their staff or bed capacities.[10] This particular diagram is of interest because it shows several contributions of members of the group which had not emerged earlier. Guided by the facilitator, participants noted that when the density of families in assessment becomes too great, entry to assessment is shut down, but families can't stay in the income support unit so there must be a potential flow into Tier II housing that bypasses the assessment process. It was also during elicitation and discussion of this diagram that participants noted that the promise or potential of permanent housing has the effect of increasing the entrance of families into the housing support system -- the links at the bottom of the figure were added to reflect what participants were saying, with all knowing that they connected to elements of the system not shown in the diagram.

The generic density or load structure representing capacity utilization has become for us an element of a productive group model building "script," which we can call upon as appropriate in other settings. It generates feedback loops in a language participants are comfortable with, their natural one-way causal language. Feedback loops emerge out of considering the effects of densities, vacancy rates, and loads. We see great potential in the modeling community for the accumulation and sharing of such scripts (see Reflections, below).

Four separate roles were clearly in evidence in this two-day group model building/model refinement workshop: the facilitator/elicitor, the modeler/reflector, the recorder, and the gatekeeper. The first two roles were handled by Andersen and Richardson, respectively, with some switching off for short periods. The role of recorder was handled by the two members of the OMB modeling team who also

10 The group repeatedly used synonyms for this density ratio, substituting capacity utilization, vacancy rate, or number of vacancies as suited the discussion of the moment.

planned the workshop with us. The gatekeeper was the director of the Operations Research Unit who had invited us, assembled the group, and took an active part in the proceedings, more as a part of the modeling team than as a participant expert on homelessness. We were missing only a process coach. Sensitive to that need, we and the modeling team all shared the duties of the role of process coach throughout the two days, observing as best we could the group dynamics at the same time we handled our other tasks.

Reflections on the group model building process and the five roles

Perceived value of recognizing the five roles

The complexities of problem conceptualization, model formulation, and group process suggest that separating the roles of group facilitator, knowledge elicitor, and model crystallizer in large groups greatly facilitates model development. Our experiments have involved from three to five actors taking these five roles. Many system dynamics practitioners have pursued group work by themselves, commonly aided by a person within the group fulfilling the role of we have identified as the gatekeeper. In such one-person shows, the system dynamics practitioner functions at various times, or simultaneously, as group facilitator, knowledge elicitor, educator, modeler, and recording secretary. At a minimum our experiments and the literatures they are based upon suggest that recognizing these multiple and conflicting roles is essential for smooth group process and effective model-based group strategy support.

But it is very likely the minimum is not enough. To accelerate group modeling to the point of conceptualizing, formulating, and simulating a reasonably complex model in two days almost certainly requires a team of several people each paying attention separate aspects of the process. Even for more traditional modeling projects in which models are built in the weeks between client group meetings, the most powerful minimum is not one person enlightened by perceiving several essential roles, but at least two people in a group modeling team, one focusing on group facilitation, knowledge elicitation, and initial drafts of structure, and the other focusing on the problem, the system being conceptualized,and refinements of structure. We suspect that the best group modeling work in system dynamics follows at least this minimal team structure, with members of the team unconsciously moving into and out of the roles we have described. Just as a fluent basketball team plays better when positions are assigned, we suspect that assigning roles in group modeling, even fluid ones, will significantly improve the play.

Skills

In our experiments the group facilitator/elicitor and the modeler/reflector have been experienced system dynamics modelers who also have considerable experience and interest in working with groups. The range of skills possessed by such people is difficult to list, and we acknowledge we don't know what subtle particular skills one might think of are really crucial.

Some of the more obvious skills fall into the category of *scripts* — planned and rehearsed routines for accomplishing subgoals in the course of a group model building workshop. The system dynamics literature containing aspects of such scripts is small but worth perusing (see, e.g., Stenberg 1980; Wolstenholme and Coyle 1983; Richmond 1987; Vennix, Gubbels, Post and Poppen 1988; Vennix 1991; EJOR 1992; Saeed 1992; Lane 1993; and Lane 1994). We view the accumulation and sharing of group model building scripts as a high priority for the field. Widespread experience with a growing collection of group model building scripts would move in the direction of an explicit and increasingly reliable set of group model building processes that modelers can acquire, practice, and extend. (See Anderson and Richardson (1994) for the beginnings of such an accumulation of group model building scripts.)

Concept models

A particular set of skills and attitudes apply to concept models, the special-purpose models with which we have begun our group modeling building workshops. Concept models are crafted specifically to introduce the stock, flow, and causal link icons to be used throughout the workshop, to demonstrate there are links between feedback structure and dynamic behavior, and to initiate discussion about the structure and behavior of the real system. Because of these sharply defined pedagogical purposes and our desire that the models should essentially "teach themselves," we find concept models tricky to build.

The principles we have evolved for formulating concept models include the following:

- Use two, or at most three, levels for the first concept model.
- Use algebra you would be willing to show to the group, even if that requires weak formulations (e.g., the grayed rates in Figure 1 are formulated as open-loop integrations, and two of the time series inputs in Figure 4 should be endogenous rather than exogenous).
- Draw the structure by hand first, explaining the icons and structural intent, before showing the computer model.
- Begin with a model that is clearly unrealistic in some obvious structural way, so the group can develop it (e.g., the first concept model in the homelessness workshop

contained no recidivism).
• Name variables conceptually, not mathematically (e.g., in Figure 1 the fraction of kids at risk admitted per month is named the "screening policy").
• Add structure that the group would suggest but prepare the additions in advance.
• Add structure that makes a dramatic difference in model behavior, usually by adding structure that contains realistic stocks or delays (the gray structures in Figures 1 and 9 are typical).
• Show at least two, and at most three, versions of the concept model, with the final version showing the most interesting, most realistic, or most surprising dynamics.

The goal of a concise sequence of two or three concept models is a participant group champing at the bit to get into the process of model building, assured that the formal models they will build are flexible tools for thinking realistically about system structure and dynamics, and that they are in control.

Do's and don'ts
A subset of the group model building scripts the modeling community should develop and share are do's and don'ts -- quickly stated activities or attitudes to definitely follow or definitely avoid. We have operated on such guidelines as "Get the group talking as soon as possible;" "Be scrupulously consistent in diagrammatic notation from one diagram to the next, and from hand drawn diagrams to computer displays;" "Script the workshop in detail, but treat the script as a framework for productive improvisation;" "Pay scrupulous attention to the geometry of seating, white boards, computers, projection screens, and the like," and so on. Some of our do's and don'ts come from the group process literature, some from intuition, some from the simple necessity of needing consistency from one group model building effort to the next, and some no doubt from our idiosyncratic preferences. We are convinced, however, that there are better and worse ways to go about model building in groups and encourage others to contribute to the accumulation and testing of do's and don'ts (See Anderson and Richardson (1994) for a development of these ideas).

Role conflicts
The modeler/reflector can interfere with the flow of group process being shaped by the facilitator/elicitor. In our experiments the modeler/reflector would occasionally present to the group and discuss reflections on the group's problem definition, system conceptualization, model formulation, and policy implications. If not done with great care, moves by the modeler/reflector can derail lines of thinking being pursued by the facilitator/elicitor.

A process coach, focusing solely on intragroup interactions, can be enormously beneficial in helping the facilitator maintain the group's motivation and momentum. However, both process and content coaches have to keep in mind that the facilitator/elicitor is, in a sense, on stage and vulnerable. Hearing that "the group is unraveling," "something must be done to energize those folk over there," and the like, can be unnerving. We have chosen the word "coach" advisedly — a coach does more than diagnose problems; a coach suggests plays. And great coaches make their suggestions with deep knowledge of the situation in the game and all the players' strengths and weaknesses.

Explainer/elicitor conflicts
Most system dynamics group work must involve some discipline-centered teaching about the approach, along with the group-centered elicitation of knowledge about the structure and dynamics of the problem. Explaining the mysteries of system dynamics or of a particular model formulation can get in the way of uninhibited group discussion centered on the problem independent of approach or formulation. A group model building team can err badly in two directions: teaching too much about the system dynamics approach and model formulations, and teaching too little about them. Teaching too much interferes with getting information about the group's problem. The group learns much about the approach, the modeling team hears mostly just what it taught, and the group's problem remains largely unaddressed. Teaching too little can lead to badly targeted group discussions that do not help the development of a dynamic, feedback view of the problem.

In our work on Vermont Medicaid, the group worked extremely well together but was reluctant to go beyond numerical data to assert causal mechanisms in the intricate doctor/patient/reimbursement Medicaid system. The modeling team pressed for some causal feedback views, but did not force an endogenous dynamic feedback view. In the end the team was left with few insights about the causal structure of critical parts of the system. The further modeling work that followed, undertaken by the Rockefeller College team and the Vermont core group, has been strong on time-series data but weak on feedback structure and insight. The Vermont model-based group work might be faulted for trying to be too responsive to the group, and for failing to do a good job presenting and motivating the system dynamics approach.[11]

11 One might also question the extent to which the concept model driven by three time series (Figure 4) biased the group in the main two-day workshop toward exogenous formulations. Our impressions are that the bias was already strongly in place, and we did not adequately counter it.

The uniquely gifted practitioner hypothesis

We believe that group model building is a mix of skills and sensitivities that any modeler can master, but there remains the question of whether some practitioners have implicit, innate capabilities that enable them to be better at it than others. Modelers must avoid falling into the trap of this assumption. However one thinks about the question, we believe that the proper course for system dynamics practitioners is to take the "uniquely gifted practitioner" hypothesis as the null hypothesis and conduct field-wide practitioner experiments designed to give the field a good chance of rejecting this self-limiting premise. Second year students should practice the arts of group modeling building in courses. Conferences should hold fish bowl exercises in which experienced group model builders demonstrate their approaches with a subset of the folk attending. Experienced modelers should try their hand at it, aided an abetted by appropriate group model building teams.

We are convinced that an enlightened ability to support groups in rapid model-based investigations is an essential component of the tool kit of all professional system dynamics practitioners.

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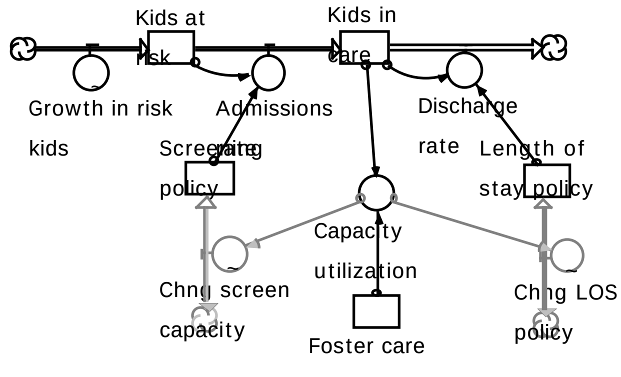

Figure 1: Foster care concept model, initially shown in the foster care group modeling workshop with constants for screening and length-of-stay. The negative loops indicated by the dotted structures were added, one after the other, bringing the case load under control, with various adverse consequences.

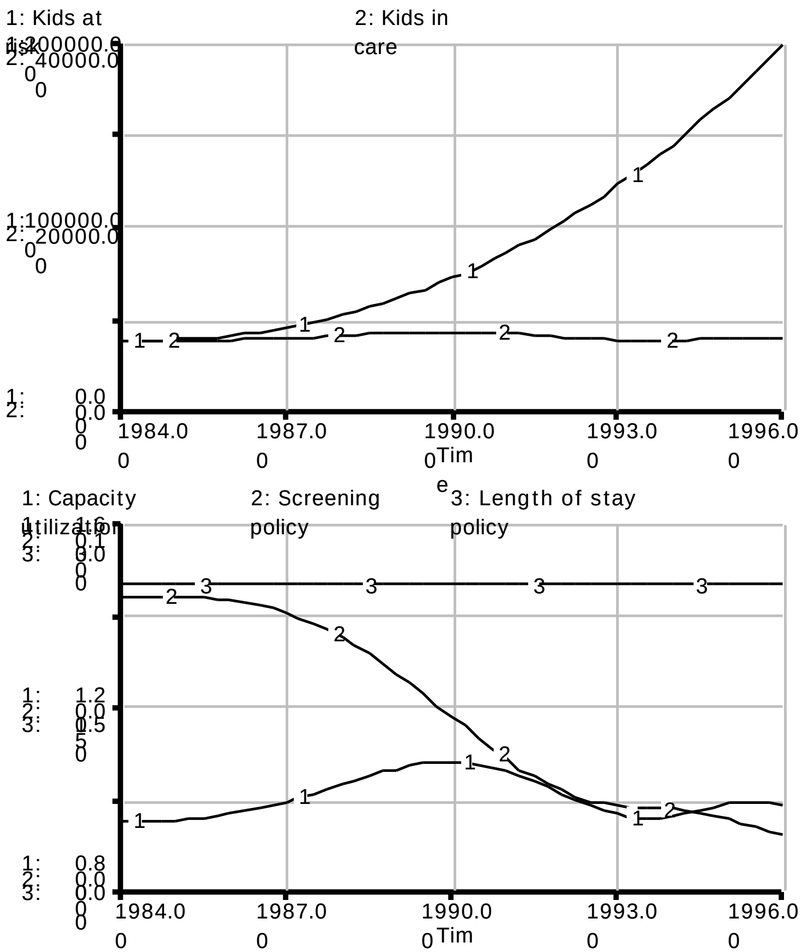

Figure 2: Foster care concept model — closing the screening policy loop

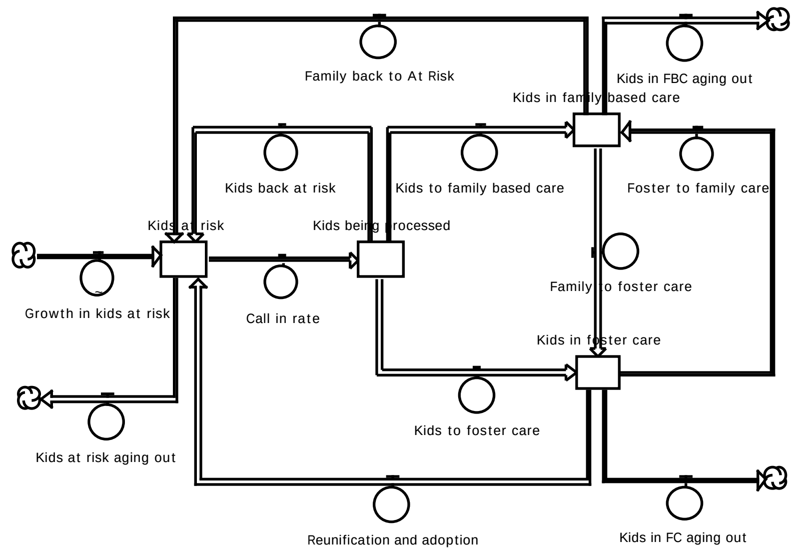

Figure 3: Stock-and-flow diagram of foster care populations conceptualized in the foster care group modeling workshop. The model formulated around this structure, parametrized, and simulated during the workshop contained more than 80 equations (10 levels) organized in four sectors: Child stocks and flows, Child Protective Services and Case workers, Care capacities, and Workload effects.

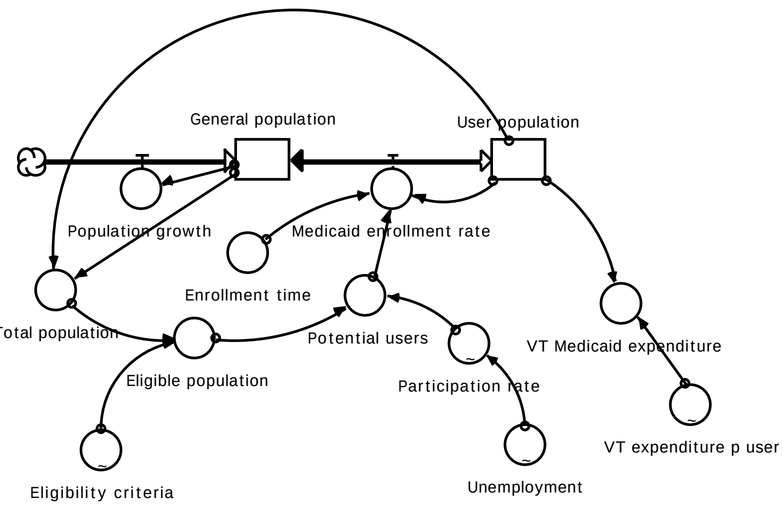

Figure 4: Initial concept model for Vermont Medicaid group model building workshops.

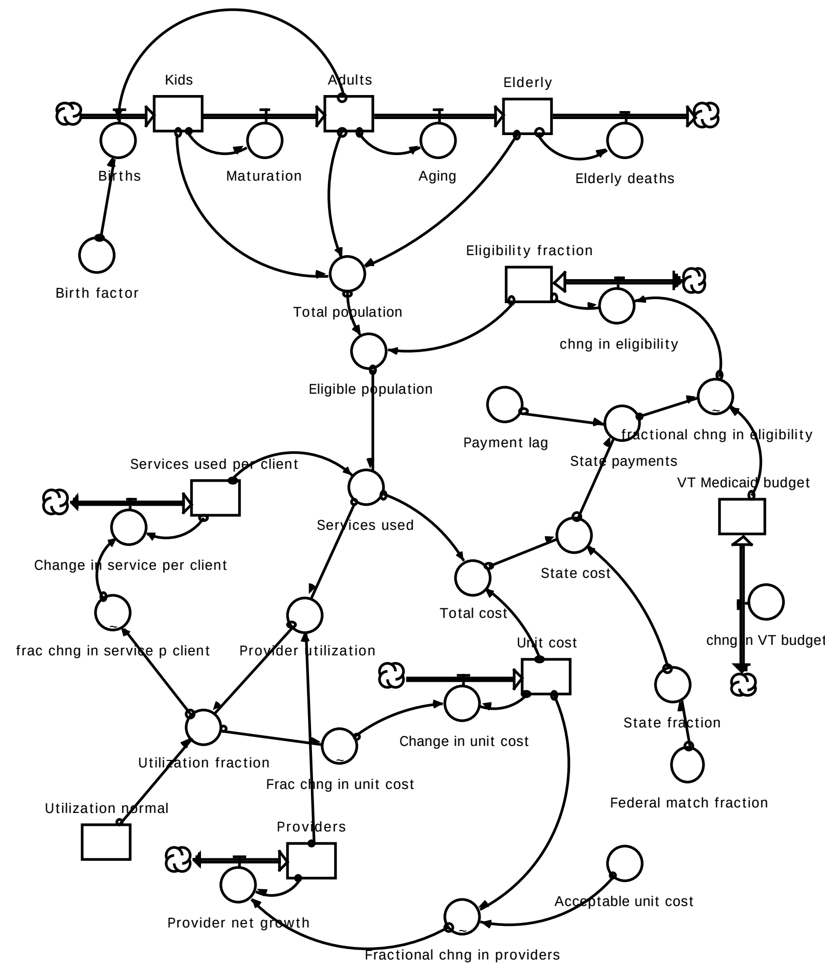

Figure 6: Simple Vermont Medicaid model developed during the first group modeling workshop. The model was formulated by the modeler/reflector while listening to the first hour-and-a-half of facilitated group discussion, presented back to the group, composed in STELLA during the break and lunch, and simulated for the group.

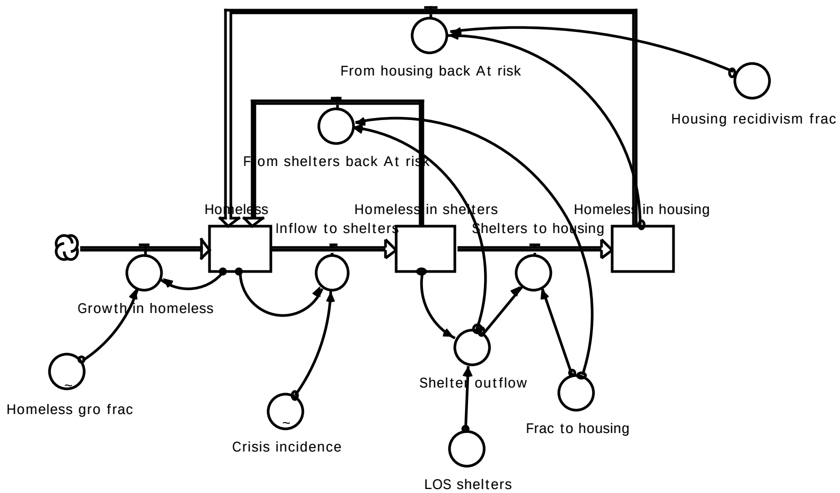

Figure 7: Second concept model in the New York City workshop on homelessness. Here, recidivism flows have been added to the simple aging chain shown in the first concept model (not shown). We showed the friendly algebra separating the shelter outflow into the flow to housing and the flow back at risk.

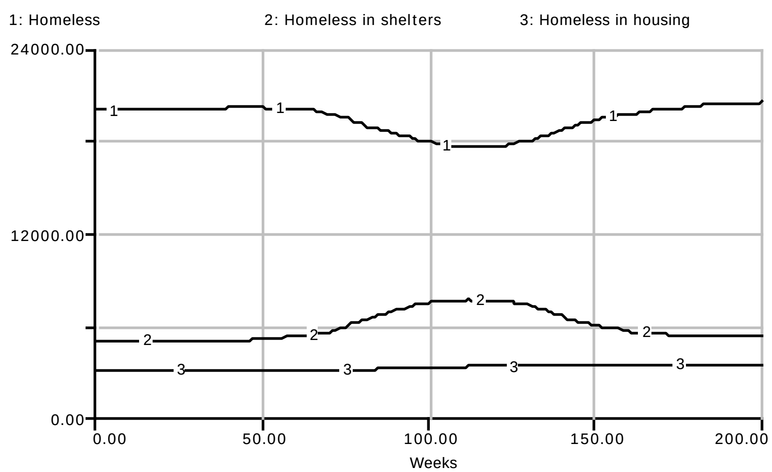

Figure 8: Dynamics of the concept model shown in Figure 7 disturbed by a short-term rise in the crisis incidence fraction.

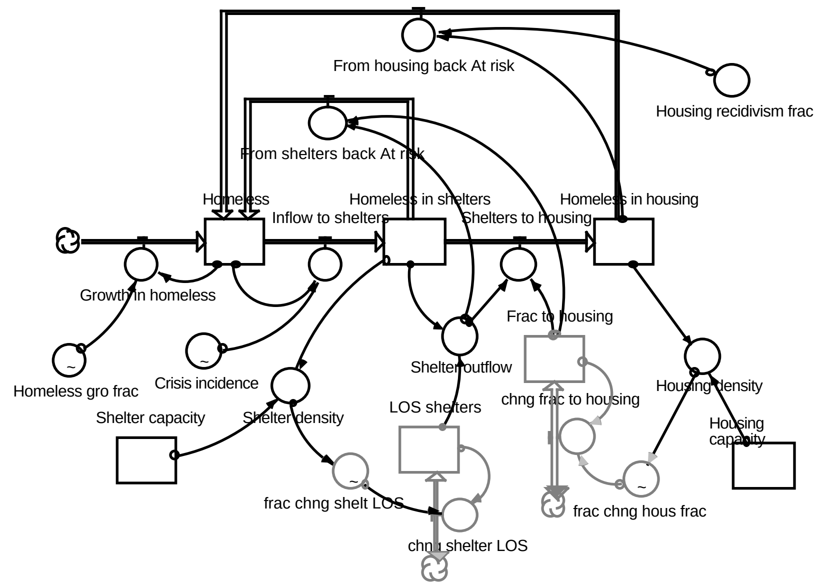

Figure 9: The concept model of Figure 8, showing a sequence of additions. First the shelter and housing density ratios were added and the model simulated. The pressures emanating from these densities (shown in gray) were then elicited from the group, formulated with them, and simulated.

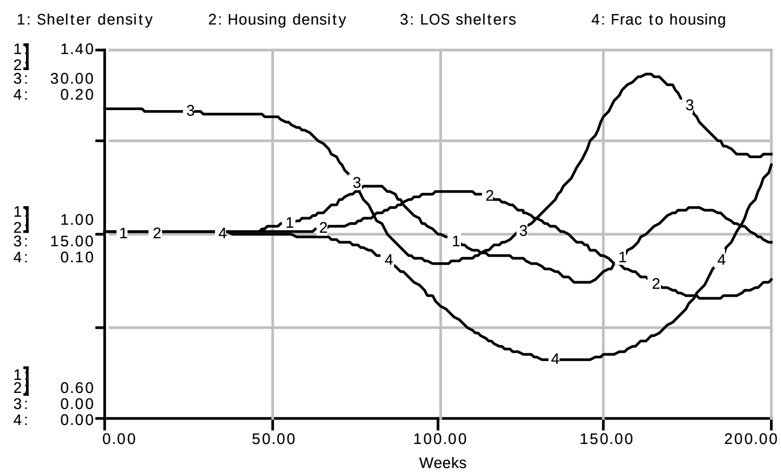

Figure 10: Dynamics of the elaborated homelessness concept model, shown in Figure 9 (including the gray elements).

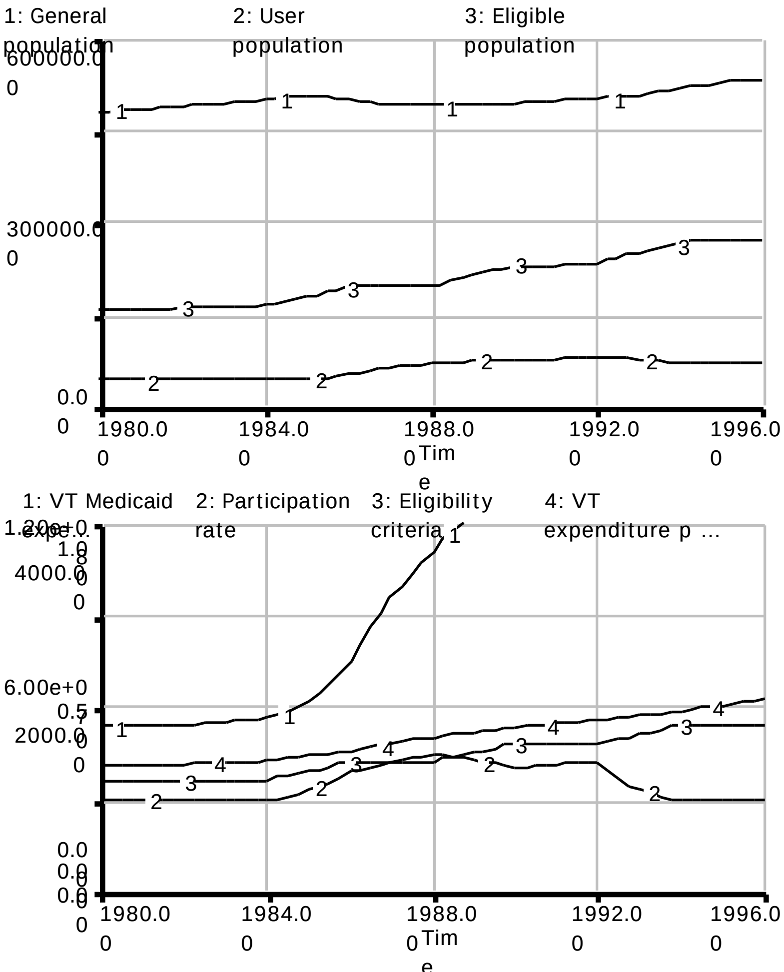

Figure 5: Vermont Medicaid concept model, with small increases in mandated eligibility, unemployment, and annual expenditures per user

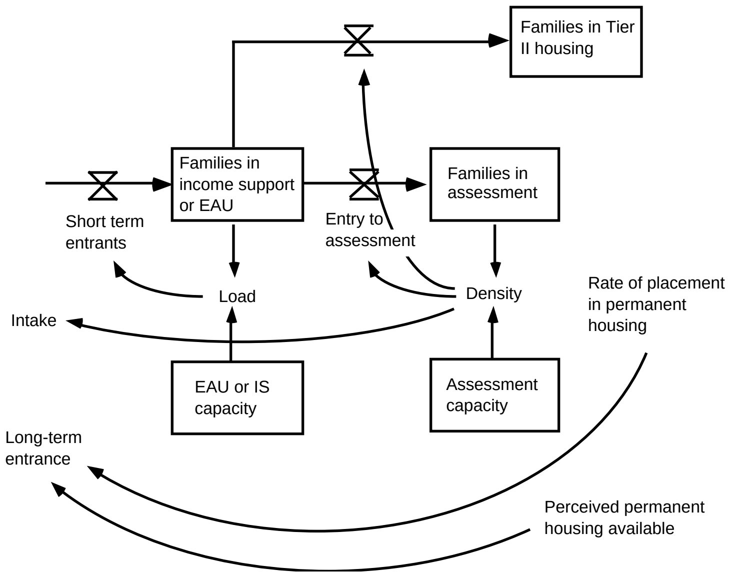

Figure 11: A typical diagram from the New York City homelessness group model building workshop, showing the use of density ratios or vacancies to elicit from the group system pressures that close feedback loops.