

Chapter 2

Group Model Building and Community-Based System Dynamics Process

Group Model Building

Group model building was initially developed in the 1980s by leaders in the field of system dynamics (e.g., Richardson and Andersen 1995; Richmond 1997; Vennix 1996) who recognized the potential of developing computer models and simulations with participants that leveraged the diagramming conventions of system dynamics (Lane 2000). This was arguably enabled by the creation of the first icon-based system dynamics software STELLA on the Macintosh, developed by Barry Richmond at High Performance Systems (now isee systems).

While system dynamics has always had a rich tradition of involving people to inform the structure, parameters, and policies to be tested in a simulation model through meetings and interviews, the development of group model building signaled a new direction in the field to involve participants more directly in the modeling process (Andersen et al. 2007).

However, definitions of group model building vary. For example, Vennix (1996) argues that this common practice of involving stakeholders in the modeling process introduces a social dynamic that can affect the quality of the model, buy-in from stakeholders, and ultimately the likelihood that recommendations will be implemented. Rather than leave this to chance, Vennix therefore argues for a more intentional approach to working with stakeholders in the modeling process and uses the term “group model building” broadly to describe “a process in which team members exchange their perceptions of a problem and explore such questions as: what exactly is the problem we face? How did the problematic situation originate? What might be its underlying causes? How can the problem be tackled?” (p. 3).

At the other end of the spectrum, Richardson and Andersen (1995) have taken a narrower use of the term to signal “the intent to involve a relatively large client group in the business of model formulation, not just conceptualization” (p. 1). In both cases, the underlying ideas are essentially the same and emphasize the benefits of involving stakeholders in the process of developing a model with the expectation

that this will not only lead to a more relevant model but shared insights, consensus, and motivation for implementing the results.

More recently, some have argued for a broader term, “participatory systems modeling” (e.g., Michaud 2012; Stave 2010), which encompasses group model building and mediated modeling (van den Belt 2004) but places more emphasis on seeing participation along a continuum of model building and formulation, from no involvement to high involvement. Much of this work sits within the environmental and natural resources decision support literature. One implication of this is that much of this work is also place based. For example, Stave (2010) talks about how computer simulation models with higher levels of participation in the modeling process are subsequently used in workshops with different participants who have not been involved in the development of the model.

One often overlooked consequence of this may be underestimating the role of stakeholder participation in early stages of model development on later benefits social learning and capital development (Stave 2010). Models that are developed in same place around public issues often have a common referent of experiences within the same community, so even when participants have not been involved in the modeling process, there can be a connection to a model developed by others from their community. Recognizing and drawing on the potential of communities to learn and build capacity over time through multiple system dynamics and group model building projects is a central idea in CBSD.

Approaches to Group Model Building

Vennix (1996) has described the design of group model building as varying along four dimensions. First, who is defining the initial issue or problem? Initially, in communities with little or no experience with system dynamics or group model building, this will often start with someone with training in system dynamics. However, as some within a community become more familiar with system dynamics or group model building, community members start to take a greater lead in defining the problem, which is explicitly pursued in CBSD.

Second, projects can be distinguished by whether or not they follow a structured or unstructured group process. In a structured group process, a detailed agenda of the group model building session is developed and usually in some collaboration with the client or sponsor of the project. In an unstructured group process, there may be a loose agenda and reliance on improvising group activities in response to the group dynamics and conversation flow. An unstructured group process generally requires high levels of system dynamics and group model building training and expertise to be successful. Because much of the emphasis in CBSD is on building capacity and designing group model building workshops that are community specific, CBSD is often a highly structured approach detailed in Chap. 5.

Third, group model building projects also differ by what type of model is going to be developed. Will the focus of the project be to develop an informal causal map¹ or a formal computer simulation model? Informal causal maps are frequently used at early stage of a modeling process to help conceptualize the system and define the problem, as well as at the end of a project to communicate the results from analyzing a simulation model, but have come to be seen as the desired output on their own, that is, without an accompanying simulation model (Lane 2000). In CBSD, the goals for any specific project can be the development of an informal map or more formal computer simulation model, but generally as capacity develops within the community, demand for computer simulation modeling develops around one or more well-defined problems based on the experience and results from earlier projects focusing on causal mapping.

Fourth, projects differ by whether or not they start a group with a “blank slate” or some initial model structure. In the “blank slate” approach, one begins the workshop rather open ended, usually through some of type of exercise that elicits issues or variables related to the problem of interest. When one starts with some initial model structure, one might use a concept model to introduce the language of system dynamics (Richardson 2013) or some type of seed or backbone structure of the system as a starting place to elicit causal structures of a system.

For example, one might start with a basic stock and flow diagram illustrating how people in a community move through different health and disease states and then ask participants to identify variables that influence the transition rates or flows between these stocks. The advantages of using an initial structure are that one is often able to more quickly introduce the language of system dynamics and not asking participants to identify elements of the system that may already be known from prior modeling activities, focus groups, key informant interviews, or the literature. The main concern with using an initial structure is that it may bias participants and create a strong framing effect on the rest of the workshop activities. So any initial structure introduced into a workshop generally has to be carefully chosen and piloted in a mock session to see whether or not the initial structure works as intended.

In CBSD, projects may begin with either a “blank slate” or some initial structure, and the choice often depends on the history of models previously built in a community. With new communities, initial conversations may take more of an open-ended “blank slate” approach to discover what some of the issues are and ground problems in the local language. Later, as projects become more focused and community members familiar with earlier efforts, going through the same open-ended exercises can start to feel like duplicating previous work and inadequately leveraging the earlier work of other community members. At this point, elements or even whole models can be shared at the start of a session.

¹ Some use the term qualitative instead of causal map to distinguish a non-simulation from a simulation model.

Teamwork

Richardson and Andersen (1995) were the first to note the importance of teamwork in group model building and identified a number of different roles that were required to facilitate a group model building workshop. They emphasized the high cognitive loads involved in attending to group dynamics, facilitating the conversation, building a model, analyzing the model and developing insights, and reflecting back observations about the model back to participants. As a consequence, they noted this work tended to always be done in teams with essentially five different roles:

- Group facilitator to lead the session with training in system dynamics and facilitation skills.
- Modeler/reflector to develop and analyze the model and then reflect back model-based insights to the participants.
- Process coach to observe the group process and provide the team with feedback.
- Recorder to take notes, document products from a session including drawings of models and dynamics with enough training in system dynamics to know what to include and what to ignore.
- Gatekeeper to represent the client perspective in selecting and recruiting participants who can advocate on behalf the client group with the modelers and on behalf of the modeling team with the client group.

As structured group model building evolved through the use of scripts, additional roles have been identified (Hovmand et al. 2012; Andersen and Richardson 1997):

- Wall builders to organize products from an exercise into thematic clusters.
- Runners to transfer products from an participants to the wall builder.
- Conveners and closers to open and close the session or workshop who have status among the participants and help set the tone for the session.
- Specific to CBSD, community facilitators who co-facilitate the workshop with the facilitator (then called a modeler-facilitator to distinguish their role from the community facilitator) and understand the local language and can identify/mitigate power dynamics among participants.

Additionally, in CBSD, we have also had roles that are specific to the setting and workshop, including:

- Translators to provide simultaneous translation between the local language and language of the modeling team when the modeling team and community do not speak the same language.
- Debriefers to lead and facilitate the debrief of the facilitation team after the group model building workshop.
- Observers to observe but not participate in the process.²

² We found it beneficial to call out the observer role explicitly as a way to define expectations about their role during the session.

- Production coordinator to handle the preparation of products generated by the modelers and recorders that are distributed during and at the end of a workshop session.
- Choreographer to conceptualize and oversee the overall design of structured group model building workshop including development of the detailed agenda, scripts, facilitation manual, and training of the facilitation team.

It is important to recognize that any given project does not need one person for every role and that some roles can be carried by the same individual. For example, the gatekeeper, convener, and closer are often the same person, and in a two-person facilitation team with a modeler-facilitator and community facilitator, one person can serve as the wall builder.

On the other hand, some roles are demanding and do not allow this. For example, recorders are nearly always working continuously through the session and rarely in a position to take on other roles without compromising the recording process. Facilitators having been in the front of the room for most of the session are also not the persons to take on the debriefer role, whereas as a process coach who has been taking notes during the workshop is often in a good position to lead the debrief after the workshop. The bottom line is that group model building is a team activity, and team performance can have a major impact on the group process that evolves and the quality and impact of the results.

Generally speaking, facilitation teams require 3–5 people with complementary skills and training. Smaller teams with less experience in system dynamics and group model building should generally start with shorter sessions (90–180 min) focusing on developing initial problem definition or conceptualizations of a system using causal maps, and with experience, they can take on the challenges to eventually facilitate full-day and multiday group model building workshops that include the development of a computer simulation model.

Teamwork and team learning can be enhanced by building into agendas structured places for the facilitation team to conference and debrief after a session with a designated person leading the debrief. Creating a predictable and safe space where initial impressions can be shared, team members have a chance to support and feel supported by the team and learn, and feeling OK at the end is critical for long-term development. One should not underestimate the impact on an individual at having completed their first session in a new role, the sense of failure when the workshop took an unexpected turn, the frustrations that arise with participants or team members, or the sadness that can hit team members upon hearing and getting a structural perspective on the hurt and suffering experienced by a community.

A structured debrief becomes especially critical when the team has to quickly regroup and put together the next session, and is necessary whether or not things went well or were seen as a failure. Team members with little or no formal training in system dynamics and group model building also benefit from this early on and will generally recognize that there will be a team there to support them when they take risks in volunteering for a new role.

Boundary Objects

The relationship between visual representations (e.g., causal loop diagrams, stock and flow diagrams, behavior over time graphs) in system dynamics and the role they play in groups has been topic of discussion among system dynamicists, but it is Laura Black (Black et al. 2004; Black and Andersen 2012) who first made the connection that these visual representations functioned as boundary objects and play a key role in group model building.

The notion of boundary objects originated in studies of distributed cognition and transdisciplinary knowledge sharing and was coined by Susan Star (1989) to describe the way visual metaphors were used to facilitate knowledge sharing across different knowledge and user domains. While the literature expanded the definition of boundary objects, in system dynamics and group model building in particular, the role of boundary objects is more specific and especially useful for defining some of the essential characteristics of group model building. More formally, a boundary object is

A tangible representation of dependencies across disciplinary, organizational, social or cultural lines that all participants can modify. It can effectively advance shared understanding when participants can transform the representation to show more clearly their understanding of the dependencies among them and the implications for each participant's resources, operations and goals. (Black and Andersen 2012, 195)

In system dynamics, boundary objects have three essential characteristics (Black and Andersen 2012). First, they are tangible two- or three-dimensional word sparse representations (e.g., diagrams with few words). Second, these representations are sufficient for participants to show key concepts, actions, and the relationships between them. Third, they are accessible and modifiable by all participants. To this list, Black reminds us that boundary objects are *social constructions* and there are several different ways that visual representations can fail to be boundary objects (Black 2013). In particular, Black has identified three general failure modes for boundary objects:

- *The visual representation is owned by one stakeholder group or knowledge domain with others deferring to this representation.* This can happen when a model is no longer seen as the group's model, but the system dynamics expert's model and participants automatically defer to the system dynamics expert's representation of their issue. Or, the visual representation is dominated by detail from one stakeholder or knowledge domain.
- *Each stakeholder group or knowledge domain develops their own independent visual representation to the exclusion of the others.* This occurs, for example, when rather than trying to negotiate and resolve the semantic differences and priorities between different stakeholder perspectives, the group fragments and each decides to build their own visual representation while ignoring other viewpoints.
- *The visual representation covers all stakeholder groups and knowledge domains without being selective in identifying key concepts, actions, and relationships.*

Similar to the second example, rather than resolving the semantic differences, the group ends up with a visual representation that essentially includes everything.

Visual representations as boundary objects in system dynamics provide what Donald Schön (1979) referred to as a generative metaphor in his study of product innovation. In particular, Schön gives an example of a product development team charged with developing a new paintbrush. Initially, the team is looking at the paintbrush as an applicator until someone on the team recognizes the paintbrush as a pump with a reservoir. The pump metaphor allows the team to think differently about the paintbrush.

The use of informal causal maps and formal models that can be simulated in system dynamics within a group model building session provides a systematic way to negotiate and socially construct a series of boundary objects with a group that can eventually serve as generative metaphors for developing system insights. In fact, much of the activity within group model building is focused on designing, building, maintaining, and transitioning a group from one boundary object to another boundary object (Richardson and Andersen 2010).

Moreover, when a group model building process tends to collapse, it is nearly always because the visual representations no longer function as a boundary object. That is, one has run into one of the three main failure modes identified by Black. This is especially useful to be aware of because it provides a framework for the facilitation team to recognize the problem in terms of failure modes of boundary objects and thereby find a way to restore the group model building process. One might even go so far as to say that the essence of group model building *is the explicit design and management of a process to a socially construct boundary objects involving system dynamics visual representations.*

Scripts

As group model building practice developed, patterns for facilitating small groups in the process of developing system dynamics emerged that Andersen and Richardson (1997) called group model building “scripts.” These were essentially standard exercises that teams would use such as setting group expectations (“hopes and fears” script), identifying variables related to a problem (variable elicitation script), eliciting dynamic stories (graphs over time script), eliciting causal structures (structure elicitation script), introducing system dynamics (concept model script), and finding where capacity and demand meet (ratio script). Initially undocumented, collections of scripts provided a playbook that teams would use to design and facilitate group model building sessions.

Later efforts to move some of the art of group model building into a science (Vennix, Andersen and Richardson 1997) stressed the need for documenting group model building sessions as a sequence of scripts (Luna-Reyes et al. 2006), the development of ScriptsMap (Ackermann et al. 2010) as a way to describe these sequences

in relation to project outcomes, and eventually the systematic documentation of group model building scripts in Scriptapedia³ (Hovmand et al. 2012). Scripts in this sense essentially form the patterns in a pattern language (Alexander 1968).⁴

An important insight in the development of ScriptsMap that was incorporated into Scriptapedia was the idea that aside from “starter scripts” used at the beginning of a group model building session, each script takes as an input a product from a previous script and generates a product as an output for a subsequent script. Another characteristic of scripts is that they generally tend to fall into one of four types of categories of group activities:

- Divergent activities designed to produced an array of different ideas and interpretations.
- Convergent activities designed to clustering and categorizing ideas and interpretations.
- Evaluative activities designed to rank and choose between options and idea.
- Presentation activities designed to educate or update participants.

A general principle of good workshop design is for sessions to mainly consist of alternating patterns of divergent and convergent group activities. Another principle that has emerged is in the use of scripts in that most if not all of the outputs from one script should be used in the subsequent script. We can think of relationship between the outputs from one script being used as an input to another script as the efficiency of a sequence of scripts within a group model building exercise.⁵

For example, in the “graphs over time” script, participants draw and then share stories about dynamics related to the problem at hand (see Fig. 2.1). This is a divergent activity that often generates a set of clustered variables with associated dynamics. In addition to the tangible graphs over time, participants usually share rich stories with causal relationships to explain the various changes in their graph over time. If the next script uses both the information on the graphs as the list of variables and the causal stories shared, participants will tend to feel that the effort was used efficiently. If on the other hand, one only uses the results from the “graphs over time” script to identify variables related to the problem and ignores the content of the causal stories that are shared by participants, then at least some of their effort may feel wasted as this did not get reflected in the next activity.

CBSD makes extensive use of scripts (Andersen and Richardson 1997) and participatory rural appraisal (PRA) methods (Kumar 2002), ScriptsMap (Ackermann

³Annaliese Calhoun coined the term “Scriptapedia” in early design conversations with Timothy Hower, George P. Richardson, David Andersen, and myself. This work was partially supported by the Center for Violence and Injury Prevention at Washington University in St. Louis through a grant from the Centers for Disease Control and Prevention (Grant Number 1R49CE001510).

⁴Jim Deering helped me see the connection between scripts in group model building and patterns in a pattern language, although George Richardson objects to this characterization because it detracts from recognizing the choreography of group model building.

⁵This was a point that Bobby Milstein identified during a demonstration group model building session as part of the 2012 Institute on Systems Science and Health at Washington University in St. Louis.



Fig. 2.1 Participant sharing story in graphs over time exercise as part of the Veteran, Battering, and Trauma project with clustered graphs in background

et al. 2010), and Scriptapedia (Hovmand et al. 2012) both as a means of designing effective collaborations with communities when teams have little or no experience in system dynamics and group model building and also a way to document and evaluate the process of group model building in communities and thereby increase the evidence based for effective group model building practice.⁶

Participants

Two of the most common questions are, (1) who should be involved and (2) how many people are needed?

Who should be in the room of a group model building session depends on the purpose of the session. If the goal of the session is to introduce an organization or community to group model building, then one should be looking for individuals who play the role of gatekeeper. If the goal of the session is to inform the design of a new program for low-income teen moms, then one should be looking for

⁶Making group model building practice evidence based is a challenging problem as most workshops and interventions are customized for the client and situation, and some if not a significant component of the process depends on facilitation (Vennix 1996). Methodologically, evaluating this entails separating specific from nonspecific treatment effects (Lohr et al. 2003), and the first step in this is to first identify what the contribution is of the specific treatment effects.

individuals who can voice the experience and concerns of teen moms in addition to the providers.

But, the reasons for involving them need to be clear. In contrast to the group model building approaches that focus decision support and therefore decision makers, a goal in CBSD is on involving participants to create a community of practice around a model that can be used to design innovations that the community will advocate for and implement. It is therefore less important in CBSD that the participants be statistically representative of the population in a community and more important that they play the role of opinion leaders or interpreters within their community.

In the design-driven literature, interpreters play a critical role in understanding how various constituencies will respond to a given innovation (Verganti 2009). They are researchers in the sense that they are inquisitive about how members from their clique respond to something and have learned over the years what their preferences are and what motivates them. As a member of the community, they can both identify with the needs *and* articulate them within a group model building session. They also play important roles within their community as opinion leaders by bringing in new interpretations of situations and innovations into the community; they have credibility in translating and conveying insights.

In terms of size, groups smaller than 5 tend to lose the dynamics that leads to a successful group model building outcome, and opportunities for sufficient interaction tend to break down in groups larger than 17 (Yalom 1995). As groups get larger, the proportion of participants diminishes and the risk of a few voices dominating the conversation increases. One way to offset this is to have multiple group model building sessions or subdivide the group into small groups.

Three Stages of a CBSD Project

CBSD projects are generally broken into three distinct stages: (1) problem scoping and identification, (2) core modeling team planning and capacity building, and (3) the actual group model building workshops (see Table 2.1). Here, we will focus on a brief overview and then describe each phase more specifically with its own chapter.

Problem Scoping and Identification

Few, if any, problems involving social systems arrive as well-defined problems that are readily amenable to the development of a formal simulation model and analysis. Moreover, issues may not be posed as dynamic problems involving change over time or have obvious feedback dynamics that are of interest. There are also questions about whether or not the type of modeling activity that would add the most value can be developed within the available time and resources, for the modelers and community partners.

Table 2.1 Three phases of community-based system dynamics projects

| Phase | Activities |
|--|--|
| Problem discovery or “scoping” | Identifying the dynamic problem to be modeled Assessing the suitability for system dynamics Developing one-page project description defining background, purpose, audience, scope, and resources needed |
| Core modeling team planning | Developing concept model, seed structures, etc. Building capacity within core modeling team Designing group model building process Creating agendas for each sessions Developing scripts Training |
| Group model building with participants | Introducing SD Variable elicitation Defining the reference mode Structure elicitation Model formulation and testing Policy analysis Transfer of ownership |

So this first stage involves, usually over the course of several meetings, discussions to identify the problem of interest and assessing the suitability of system dynamics and group model building. The output from this is usually a draft modeling project description that describes the potential modeling project defining background and motivation for the project, the dynamic problem of interest, the purpose and audience for the model, its scope, and resources and values that are needed.

This is an internal document, a description of the potential modeling project, and serves as a charter or mission statement of sorts for the model if the group decides to proceed. It is not a project proposal or something that one would generally circulate to external stakeholders or funders. Keeping it short (one page or less) is important because at this stage, one wants to minimize the investment in a potential project before people have developed a clear idea of what the project would be about.

Time invested at this stage can range from 1 to 3 hours over one or more meetings stretched over several weeks or months with interim discussions or email exchanges to clarify the modeling project description. There can be many good reasons for not proceeding at this stage, which are covered in more depth in Chap. 3, but should there be decision to proceed, a more formal proposal or bid is developed at this stage.

Core Modeling Team Planning and Capacity Building

Once the project has resources secured and the necessary approval to begin, a core modeling team (CMT) is recruited to lead the design of the group model building workshops. Members of the core modeling team usually include individuals involved in the initial conceptualization of the project during the problem scoping

phase and other individuals who are either members of community or have sufficient experience working in the community to serve as proxies. The CMT is generally a small team of 5–7 people who are “process tolerant” as this is the process of designing the process for building a model.

The primary task of the core modeling team (CMT) is to design the group model building workshop, which begins with an initial orientation to system dynamics and group model building and then moves on to developing a process map of participant groups and sessions, detail agenda, adaptation and development of scripts, preparation of a facilitation manual, and recruitment and training of the facilitation team. This can usually be accomplished within five 2-hour meetings.

Group Model Building Workshops

After the planning process, the CMT takes on a new function and essentially serves as a steering committee or workgroup to oversee the development of model through the GMB workshops. Some members from the CMT during the planning phase may continue on in this phase, while others drop out being more interested in seeing the final results at the end of the GMB workshops.

The CMT also serves as the facilitation team that leads the actual GMB sessions and is typically a mixture of members from the previous CMT and new people who have been recruited to fill specific roles in the GMB workshop design. A training or “dress rehearsal” prior to the first session is generally required even with an experienced team to make sure everyone understands their roles as well as to identify and solve unanticipated problems in the workshop design.

The actual group model building workshops then take participants through a series of exercises and facilitated discussions that have been organized by the CMT. Depending on the design, these can involve one short 90–120 minutes session with a small group; several workshops with the same design replicated several times with different groups, 1- or 2-day workshops with one group, or time separated workshops over weeks or months with the same group. Sometimes the participants in the workshop are the main audience for the modeling, but other times a larger community forum is held for sharing the results and involving a broader group of stakeholders.

After GMB workshops, recorders’ notes, causal maps and models, potential leverage points and recommendations, and other products are reviewed by the CMT. Participants are often invited to the review sessions and welcomed to join the CMT if they are interested. The CMT then proceeds to work on the model and prepare for the next session, community meeting, or final presentation of results.

Evaluation, Reporting, and Next Steps

At the completion of the group model building project, the CMT considers project process and outcomes relative to the original modeling project description. Informal evaluations can happen at the end of the last session with a review of the “hopes and

fears” from the first workshop session, or follow a rigorous approach using surveys and other evaluation methods. These are generally summarized in report to the original sponsor with a clear statement about what the outcomes were with respect to the workshop goals and objectives in the modeling project description and discussion of the next steps after this project.

Conclusion

This chapter has provided a brief overview of group model building with specific attention to concepts that pertain and used in CBSD including the importance of teamwork, the use of scripts, and the role of visual representations in system dynamics serving as boundary objects. This introduction is not mean to serve as a description or primer for group model building in general. For a general and highly accessible overview of general group model building practice, readers are encouraged to take a look at Vennix’s (1996) book, *Group Model Building*. This chapter has also introduced the three main stages of CBSD, which will be expanded in more detail with practice examples in the next three chapters.

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