Reflecting on Zagonel's dichotomy of microworlds and boundary objects

Laura J. Black

NOTES AND INSIGHTS

Reflecting on Zagonel's dichotomy of microworlds and boundary objects

Laura J. Black*

Abstract

Aldo Zagonel's distinction between "microworld" and "boundary object" approaches to modeling suggests we ask ourselves pointed questions about what we are valuing, under what conditions, as we involve stakeholders with system dynamics representations. Reflecting on developments in both participatory modeling and large system simulations, I propose that Zagonel's dichotomous descriptions lie along a continuum, with room for scholars and practitioners to explore more explicitly the multiple ways we adapt system dynamics methods to the needs and capacities of the stakeholders with whom we are working at that time. Regardless of approach, whether simulation models or causal diagrams, modifiable in the moment or fixed by design, the goal of using system dynamics representations remains focused on fostering intelligent action among the stakeholders facing the problem of focus.

Keywords: Boundary objects, microworlds, stakeholders

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Multiple paths to high stakeholder involvement

Over the last decades, scholarship on constructing models with high stakeholder involvement—termed "group model building" or "participatory modeling" (Andersen and Richardson, 1997; Luna-Reyes *et al.*, 2006; Richardson and Andersen, 1995; Vennix, 1996)—has grown significantly. Undertaken with significant facilitative skills as well as system dynamics modeling expertise, the work takes shape in small-group settings, with participants drawing graphs of behaviors over time, identifying variables, arguing openly about causal links' existence and direction, and (when dynamic hypotheses are advanced to formal simulation models) offering parameter values and stocks' initial values, reasoning through equations' logic, and proposing simulation scenarios to gain insight into their "messy problem" (Vennix, 1996, 1999).

Contemporaneously, the use of microworlds—simulating models that stakeholders use to learn about the complexities of a given challenge, such as growing a business profitably and sustainably (Boom and Bust Enterprises), keeping fisheries and the livelihoods they support viable (Fishbanks), or providing health care to a regional population at a reasonable cost (ReThink Health)—has grown more sophisticated and more widespread. Large cohorts of entering graduate students may simultaneously "compete" in a particular simulation, and groups of an organization's employees may participate in scenario simulations and debriefs on a complex societal challenge such as mitigating risks and consequences of climate change (C-ROADS and En-ROADS).

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As these uses of system dynamics have expanded, conversations and scholarship about what can be learned from qualitative and quantitative approaches to system dynamics methods have also expanded. In this context, the previously unpublished paper by Aldo Zagonel (2024) sheds light on different strategies for using system dynamics with stakeholders. In this 2007 paper, Zagonel draws in stark relief competing and intertwining goals of modeling with others: he portrays creating a representation of reality useful for experimenting and learning as the microworld approach; he calls creating a representation that reflects and expands the partial, subjective understandings of multiple stakeholders the "boundary object approach." He portrays these as "ideal types," casting models-as-microworlds as influenced by a positivist philosophy and models-as-boundary-objects as influenced by a constructionist epistemology, as he describes each during the problem definition and model conceptualization phases of a project. Interestingly, he quotes some of the same system dynamics modelers and scholars to elucidate each "ideal type" portrait, acknowledging that both ways of thinking are almost certainly in use as we build representations with system dynamics methods and interact with stakeholders.

Cross-pollinating conversations

Years ago, when Aldo and I were doctoral students, he at the University at Albany's Rockefeller College of Public Affairs & Policy, and I at MIT's Sloan School of Management, we benefited from a "system dynamics colloquium" in which students in each program (which grew to include students and faculty at Worcester Polytechnic Institute) visited each other's campus once a semester for a day of presenting our works-in-process. The students and faculty who participated had generative conversations about our respective projects and shared good food and an occasional hike. At these colloquia, we valued freedom to explore and reexplore the theories, concepts, empirics, and models in progress of our research (occasionally reminded by David Andersen: "The only good dissertation is a DONE dissertation"). At the time, Aldo and I were working in widely different substantive areas. I was studying product development at a Midwest U.S. vehicle manufacturing company, and he was on a project using the (then emerging) approach of group model building applied to county-level implementation of new federal welfare reform policies in upstate New York. As different as our topics were, we found common ground for fruitful discussions about our methods. I presented work in process on the extent to which product development teams at my research site collaboratively (or not) used sketches, prototypes, and other artifacts as "boundary objects" (Star and Griesemer, 1989); I was significantly influenced by thesis committee member Paul Carlile, who later wrote widely cited articles on boundary objects and knowledge transfer and transformation in work crossing organizational lines (Carlile, 2002, 2004).

Perhaps these colloquium conversations led Aldo to explore the ideas first shared in a 2002 conference paper and then articulated more clearly here in the 2007 paper, comparing models-as-boundary-objects with models-as-microworlds (Zagonel, 2024). By contrasting these ways of thinking, and even exaggerating their differences, his work provokes us to become more aware of our own thought

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processes—and what we are valuing, under what conditions, as we construct models and work with stakeholders to understand problems in systemic ways.

Growing depth in participatory modeling

In the years following the friendly doctoral student colloquia, as I constructed models for and with the people working in product development at my graduate-study research site, and then later participated in group model-building sessions at the University at Albany's Center for Technology in Government (and still later undertook participatory modeling with clients), I appreciated more deeply that the visual representations at the core of system dynamics methods often serve as boundary objects. Boundary objects are tangible representations that show dependencies among stakeholders and are modifiable by participants (Carlile, 2002) as they discuss the consequences of their dependencies on one another's actions. Eventually I sought to articulate the value of deliberately using representations as boundary objects in the context of stakeholder-driven system dynamics work (Black, 2013; Black and Andersen, 2012).

During the last years, innovative work has taken shape in participatory modeling, focused on co-creating and modifying representations as stakeholders are guided by modeler-facilitators. *Community Based System Dynamics* brought needed attention to the philosophical foundations and sociological contexts for system dynamics participatory modeling, as well as provided methods for using models and the modeling process in large social settings (Hovmand, 2014). Scriptapedia (Hovmand *et al.*, 2011), an open-source catalog of process segments or "scripts" for participatory modeling, has offered a focus for innovations in adapting system dynamics methods to group involvement while also serving as a source of consistency in designing sessions.

Some recent participatory modeling scholarship stretches beyond Zagonel's boundary-object characterization. For example, researchers conducting modeling in developing countries have explored what we understand about a representation's capacity to serve as a boundary object (Ballard *et al.*, 2021), as they navigated boundaries of language (using translators), custom (in which women do not speak when men are present), and expertise (when literacy levels make words less useful than pictures). Others have extended participatory modeling practices beyond the more common focus of problem specification and model conceptualization in ways that challenge Zagonel's boundary-object view as focused on process as much as or more than on the model's accuracy in representing reality. For instance, some have used group model-building processes to convene scientific experts to elicit parameter values and data sources and to calibrate large models (Hosseinichimeh *et al.*, 2017). In more recent work, Hosseinichimeh, MacDonald, et al. (2022) and Hosseinichimeh, Williams, *et al.* (2022) have leveraged group model-building techniques by using scripts to elicit from subject-matter-expert participants suggested references for key publications related to causal factors identified in the workshops, and then they statistically analyzed longitudinal data and ranked policies by effectiveness, yielding an outcome one might anticipate from a microworld approach.

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Growing breadth in large system simulations

Innovative work has also unfolded in simulating models offering useful representations of real-world systems, termed "microworlds"[i] in Zagonel's (2024, this issue) article. Milstein and others' work with Re-Think Health, for example, in which users try different policy levers to improve a region's health care and health quality, has won recognition and widespread appreciation for providing people with experiences of the many compensating feedbacks that work to undermine improvement efforts (Homer *et al.*, 2016; Homer *et al.*, 2020). En-ROADS, a model of the effects of carbon emissions on the earth's changing climate, has also gained attention as an effective way to help users experience the challenges of devising policies that prevent the most disastrous effects of pollution and industrialization's other consequences (Kapmeier *et al.*, 2021). These large models document the many ways they incorporate published scientific findings from a variety of disciplines to initialize stocks, estimate parameters, and calibrate model behavior to historical data in multiple variables. Similar to the characterization of microworlds in Zagonel's work, they are not models users can alter, except through the policy levers offered by the model's designers.

Notably, more recent use of some microworld models has included a variety of structured social interactions, such as stakeholder role play or facilitated debriefing conversations. For example, McFarland *et al.* (2016) depict the learning gained when student teams play stakeholder roles as part of the ReThink Health simulation, and Kapmeier *et al.* (2021) describe how groups of employees exploring policies to reduce climate damage using the En-ROADS simulator then engage in facilitated debriefs. These structured social interactions in the context of microworld exploration provide paths to helping participants describe and internalize where they themselves are represented in the system, where they as individuals or groups can take actions that contribute to or mitigate trends and how policies and actions of their own organizations may amplify or undermine progress in society's largest challenges. These social interactions, often facilitated by people skilled in both modeling and group processes, are akin to group modeling sessions, not in their focus on constructing representations of their shared experience of the problem, but in their focus on helping people recognize themselves and their actions within the system under discussion.

Rather than dichotomy, a continuum

What Zagonel represents as distinctly different "straw men" may be usefully recognized as points along a continuum, and those points evolve over different time scales. While some models-as-microworlds draw on published scientific findings, models-as-boundary-objects often take shape in organizations in which lived experiences are not documented or theorized systematically, so there is no "science" to supplement people's understanding of their "messy problem." Even

[i]Although Zagonel uses the term "micro world" to indicate more than game-like learning simulations, here I focus on microworlds (sometimes called "flight simulators") because I believe they are indeed "an expert's representation that might challenge stakeholders' perspectives" (Zagonel, 2024), and because structured social interactions associated with microworlds (e.g. Kapmeier *et al.*, 2021; McFarland *et al.*, 2016) have been described in recent literature.

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scientific literature may not be consistent, leading to a range of parameter values permitted in a microworld (e.g. Kapmeier *et al.*, 2021). Over longer time horizons, science itself is socially constructed (Kuhn, 2012; Latour and Woolgar, 2013; Sterman and Wittenberg, 1999), as scientists, reviewers, journal editors, and academic societies shape presentations of new findings, much as a boundary object.

The image of a continuum suggests there are many dimensions that we can tease out as we situate system dynamics methods to specific purposes and stakeholders. As we recognize the social dynamics within which each system dynamics effort takes shape, we can think more deliberately about how to wield methods and representations to make the work effective for the people seeking insight. Both practice and scholarship will benefit from more explicit attention and descriptions of our choices, given what stakeholders are facing and given what we are facing as we work with them. Processes that serve well in a small-group model-building session may not easily engage groups of 50 or 100. The relative expertise of stakeholders in using representations and models (of any kind) should also inform our efforts to work with stakeholders as we meet them where they are and build their capacities for addressing complex problems.

To explore the insights arising from Zagonel's dichotomous view of what is valued in modeling under different circumstances (Zagonel, 2024), we might consider the proverb we often repeat, "All models are wrong; some are useful"[ii]—and add: *useful to whom?* That is, we can ask: To *whom* can this model be useful? *How* can it be useful? Who needs to *act* on what they learn from this representation, and what are their respective *capacities to act*? Large contentious groups of stakeholders may be moved closer to shared understanding and coherent joint action by a causal diagram they co-create with many modifications in facilitated conversations. Health policymakers may be better served by expertly calibrated many-parameter models that simulate scenarios exploring how to reduce infant and maternal mortality. We can adapt our uses of system dynamics methods and representations to serve the stakeholders who need to act jointly, from their respective positions (Blumer, 1986), to address a systemic problem.

Joint hopes for stakeholder action

Jay Forrester said, "Structure determines behavior," meaning that the structure of a system shapes the trajectories of the variables in it. My longtime colleague Don Greer has often emphasized, "And information determines structure," meaning that, to change the structure of a system, we must alter the information to which people are giving their attention.[iii] Microworlds' model structures, as experienced by simulation participants, invite them to consider policies that can produce the

[ii]Attributed to British statistician George E.P. Box.
[iii]While Don Greer spent much of his career designing and developing high-reliability, operations-integrated information systems, and therefore deeply appreciates the power of information to shape people's (employees', customers', competitors') processes, actions, and expectations, the idea of information influencing structure is portrayed graphically in Sterman's work. "Learning In and about Complex Systems" (Sterman, 1994; also Sterman, 2000, Chapter 1) describes a link from Information Feedback (from Virtual World and Real World) to Mental Models, which in turn influences Strategy, Structure, and Decision Rules. Sterman emphasizes that information from the Virtual World (unlike from the Real World) offers reduced bias and delays. Here I am encouraging us to *value explicitly choices we make about information* that we create, modify, attend to, and share because it shapes our perceptions of opportunities to act.

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desired behaviors. Through experiences of trying different policies and discussing their outcomes—the information they gain—they can see how their actions and decisions, placed in the broader context of the system represented, create the simulated outcomes. They are challenged to attend to information and take actions in their personal and organizational lives that, over time, can lead to changing structures in society. When constructing models as boundary objects, the participants—contributors to building the model's structure—use their discussion of implications from the dependencies, delays, and accumulations represented to consider not only altering the model's structure to more accurately reflect their dependencies but also altering their own communication paths and procedures—the information they share—because they can *see* in the representation the difference it can make.

Ultimately, our efforts at representing systems are meant to support more intelligent action of the stakeholders creating and inhabiting the problems of focus. We hope that people interacting with system dynamics representations, whether simulation models or causal diagrams, modifiable in the moment or fixed by design, recognize feedback among the variables and how it shapes the behaviors observed over time. Moreover, we hope that feedback from our own experiences of using system dynamics representations, whether as microworlds or boundary objects, travels through our brains to modify our own mental models and in turn shapes our conversations and actions as we work with others to understand problems systemically and then act in different and more insightful ways.

Biography

Laura Black's research focuses on cross-boundary collaborative practices and getting great work out of groups. She is a professor of management in Montana State University's Jake Jabs College of Business & Entrepreneurship.

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