METHODS BRIEF

Evaluating System Change: A Planning Guide

April 2010

Margaret B. Hargreaves

MATHEMATICA
Policy Research, Inc.

METHODS BRIEF

Evaluating System Change: A Planning Guide

April 2010

Margaret B. Hargreaves

MATHEMATICA
Policy Research, Inc.

P.O. Box 2393
Princeton, NJ 08543-2393
(609) 799-3535
www.mathematica-mpr.com

Evaluating System Change: A Planning Guide

Interest among foundations, governments, researchers, and social entrepreneurs in large-scale social change has led to an increased focus on the design, implementation, and evaluation of system change interventions (Brest and Harvey 2008; Leischow et al. 2008). Examples of real-life system interventions include (1) an initiative to use an integrative systems approach to revitalizing cities, connecting low-income residents to economic opportunities; (2) a collaborative that uses transdisciplinary systems principles to develop and deliver tobacco control interventions; and (3) a federal initiative to build systems supporting the implementation, scale-up, and sustainability of evidence-based home visiting programs to prevent child maltreatment (Leischow et al. 2008; Koball et al. 2009; Living Cities 2010).

ISSUES AT A GLANCE

This methods brief provides guidance on planning effective evaluations of system change interventions. It begins with a general overview of systems theory and then outlines a three-part process for designing system change evaluations. This three-part process aligns (1) the dynamics of the targeted system or situation, (2) the dynamics of the system change intervention, and (3) the intended purpose(s) and methods of the evaluation. Incorporating systems theory and dynamics into evaluation planning can improve an evaluation's design by capturing system conditions, dynamics, and points of influence that affect the operation and impact of a system change intervention. The goal is to provide an introduction to system change evaluation planning and design and to encourage funders, program planners, managers, and evaluators to seek out more information and apply systems methods in their own evaluation work.

Overview of Systems Theory

There are many variants of the term *system* in current use, including *systems of care, systems of service delivery*, *systemness,* and *systems thinking. Systems of care* refers to aligned networks of structures, processes, and relationships that are grounded in values and principles that provide families with access to services and supports across administrative and funding jurisdictions. It involves collaboration across agencies, families, and youth for the purpose of improving access to care and expanding the array of coordinated community-based services and supports (Research and Training Center for Children's Mental Health 2009a). *Systems of service delivery* refers to the transfer of goods and services from one source to another and to the organizational relationships among distributors of goods and services, such as providers and consumers of social welfare benefits in a community (Research and Training Center for Children's Mental Health 2009b). *Systemness* concerns the degree to which something shares the attributes of a system, such as the integration of service providers and their level of coordination, teamwork, shared learning, shared responsibility, and aligned financial incentives, as opposed to services that are uncoordinated, fragmented, and operating within silos (Crossover Health 2009). Although these concepts share certain system attributes (they all have boundaries and defined relationships), this guide is concerned with the theoretical underpinnings of systems—that is, elements that define systems and influence system change. This focus is important for evaluating system change initiatives (Hargreaves and Noga 2009).

There are many variants of the term system in current use, including systems of care, systems of service delivery, systemness, and systems thinking.

All systems share certain basic attributes or conditions, called boundaries, relationships, and perspectives. Together, these system conditions generate patterns of systemwide behavior that are called system dynamics.

A system's dynamics can be unorganized (random), organized (simple or complicated), or self-organizing (complex, adaptive).

WHAT IS A SYSTEM?

A *system* is a configuration of interacting, interdependent parts that are connected through a web of relationships, forming a whole that is greater than the sum of its parts (Holland 1998). Systems are overlapping, nested, and networked; they have subsystems and operate within broader systems (von Bertalanffy 1955; Barabasi 2002). For example, a social service program with teams of social workers may be located in a department within an organization in a community that receives funds from state and federal governments. On a less formal basis, the team members may also participate in cross-departmental projects, volunteer in community groups, chaperone school events, attend regional conferences, serve on state advisory boards, work with national professional associations, and reminisce with schoolmates on social networking websites. Each person is connected to his/her own network of colleagues, family, friends, and acquaintances. These webs of relationships create intricate patterns of systemwide activity.

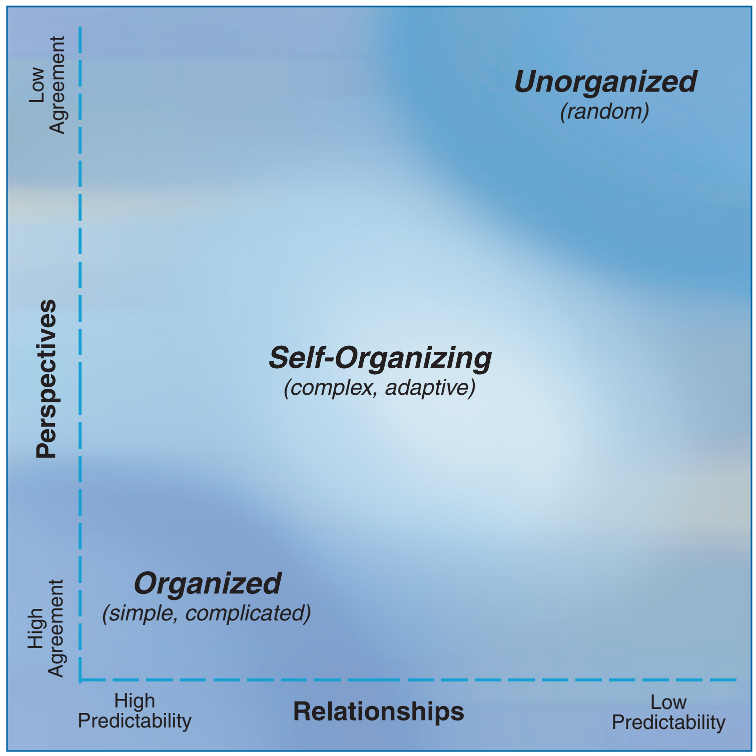
Just as systems can range in scale from the individual level to the group, community, society, and policy levels, system change interventions can also range in size from projects affecting small organizational workgroups to large, multilevel, multi-sector change initiatives (Mabry et al. 2008). Systems are also scalable; that is, patterns of activity or behavior at one level influence and are influenced by patterns at other levels (von Bertalanffy 1955). However, all systems share certain basic attributes or conditions, which are called "boundaries, relationships, and perspectives" (Midgley 2007; Williams and Imam 2007; Cabrera et al. 2008), "conditions of self-organization" (Wheatley 2001), or "containers, exchanges, and differences (CDE)" (Olson and Eoyang 2001; Eoyang 2007).

Together, these system conditions generate patterns of systemwide behavior that are called *system dynamics*. A system's dynamics can be unorganized (random), organized (simple or complicated), or self-organizing (complex, adaptive) (Zimmerman et al. 1998; Snowden and Boone 2007). All dynamics can be present within a system; over time, the balance of dynamics in a system may shift (Patton 2010a). If relationships are predictable and there is agreement on a system's goals, system dynamics are typically simple and organized. If there are no common goals or connections, dynamics are often chaotic and unorganized. Between these scenarios is an area of interdependence, interaction, and negotiation among system parts called the "zone of complexity" (Stacey 1993: Parsons 2007; Hargreaves et al. 2010) (Figure 1). These types of system dynamics are described below.

- *Random or unorganized system dynamics* are characterized by extreme turbulence and volatility, in which there are no clear patterns of interaction between system parts or actors, and no clear understanding of how to move forward (Zimmerman et al. 1998; Olson and Eoyang 2001). In random situations, people focus on their own survival, reacting blindly or avoiding action, as in the aftermath of the 2005 Hurricane Katrina and the 2010 earthquake in Haiti (Dorell and Leinwand 2010). People may also act independently and focus on their own interests, such as scientists working on their own investigator-led research grants.

- *Simple organized dynamics* are characterized by fixed, static, and mechanistic patterns of behavior, as well as linear, direct cause-and-effect relationships between system parts. The impacts of simple actions are predictable. Examples include laboratories and accounting departments, in which workers precisely follow preset policies and procedures to produce consistent, reliable results. Simple systems can be reduced to their parts; best practices are identified and replicated through protocols (Zimmerman et al. 1998; Olson and Eoyang 2001).

Figure 1. System Dynamics Landscape Diagram



Source: Adapted from Stacy 1993; Parsons 2007.

- In more *complicated organized systems*, leaders plan and coordinate the activities of multiple teams or parts. Examples include orchestras and manufacturing plants, in which separate groups fulfill unique functions that contribute to a larger effort; their efforts are directed by conductors or plant managers. Networks of organizations can be linked through contractual arrangements or memoranda of understanding (Goldsmith and Eggers 2004; Kamarck 2007). Because of circular, interlocking, and sometimes time-delayed relationships among units or organizations in complicated systems, unexpected results can occur through indirect feedback processes (Forrester 1975; Senge 1990). Self-reinforcing feedback can throw a system or situation out of balance by continuously amplifying or increasing small initial changes. Self-correcting feedback loops between parts help maintain system equilibrium by counterbalancing and neutralizing a change in the system. An example of self-correcting feedback is policy resistance—"a tendency for interventions to be defeated by the system's response to the intervention itself" (Sterman 2006).

Complex systems are adaptive; actors learn and coevolve as they interact with one another and respond to changes in their environment.

System interventions seek to change systemwide patterns of behavior among actors by changing underlying system dynamics, structures, and conditions.

When system conditions and dynamics are not considered in an evaluation's design, the evaluation will inevitably miss crucial aspects of the intervention and its environment that are affecting the intervention's operation and success.

- *Complex system dynamics* are characterized by massively entangled webs of relationships, from which unpredicted outcomes emerge through the self-organizing interactions of many parts or actors within and across system levels (Holland 1995; Eoyang 2007). Complex systems are adaptive; actors learn and coevolve as they interact with one another and respond to changes in their environment. For example, in economic markets, price wars between competitors can produce a buyer's market for consumers. Sensitive to small changes, complex systems are inherently unstable and can experience discontinuous "phase changes" at thresholds or tipping points like chemical reactions (Prigogine 1989). For example, a neighborhood can tip from white to black when a critical mass of blacks moves into an area; the release of Nelson Mandela from prison in 1990 set in motion the end of South Africa's apartheid government (Kauffman 1995; Gladwell 2000). Another example is the 2008 meltdown of financial markets around the world, followed by a global recession, which was triggered by mortgage defaults in the U.S. housing market.

Systems Theory and Evaluation Planning

System interventions seek to change systemwide patterns of behavior among actors by changing underlying system dynamics, structures, and conditions (Wheatley 2001; Eoyang 2007). These dynamic interactions set systems apart from inert collections of objects; such dynamics also set system change evaluations apart from other kinds of evaluations. *Systems thinking* provides a perspective that emphasizes the patterns of interrelationships between parts and the whole rather than the parts in isolation (Trochim et al. 2006; Parsons 2007; Hargreaves and Parsons 2009). It also focuses on operational thinking (concentrating on causality and how behavior is generated), rather than factors thinking (listing the factors that influence or are correlated with some result) (National Cancer Institute 2007). Systems thinking can help funders, program administrators, and researchers incorporate system dynamics into an evaluation's design and methods. The more complex, interactive, and unstable the dynamics of a situation or intervention, the more helpful it is to use systems thinking in planning and designing a system change evaluation.

The kinds of evaluation questions that can be answered through the use of systems theory depend on the purpose(s) of the evaluation. Evaluation purposes can be developmental, formative, summative, or focused on monitoring and accountability (Patton 2008). Systems thinking can be used in evaluations targeted toward all four types of purposes by aligning evaluation approaches and methods with the dynamics of the intervention and its situation or context. Appropriate system evaluation designs recognize and take into account the system dynamics of the intervention's context or situation, the dynamics of the intervention itself, and the purposes of the evaluation. Many, if not most, situations and interventions encompass multiple dynamics simultaneously or in sequence; likewise, evaluation designs may incorporate multiple dynamics. For example, the Cross-site Evaluation of the Supporting Evidence-based Home Visiting Grantee Cluster was designed to address simple, complicated, and complex system dynamics (Hargreaves and Paulsell 2009; Koball et al. 2009). However, when system conditions and dynamics are not considered in an evaluation's design, the evaluation will inevitably miss crucial aspects of the intervention and its environment that are affecting the intervention's operation and success.

System Change Evaluation Planning

To address the challenge of planning a system change evaluation, this introductory guide includes a System Change Evaluation Planning Worksheet (p. 15), which is designed to help evaluators identify three key elements of a system change evaluation: (1) the complexity of the dynamics of the system or situation of interest; (2) the complexity of the dynamics of the system change intervention; and (3) the intended users or stakeholders, purpose(s), and methods of the intervention's evaluation (see Appendix). Each element has three subcomponents (listed below). Together, these form the foundation of a system change evaluation plan.

System Change Evaluation Elements		
System or Situation	**System Change Intervention**	**System Change Evaluation**
• Boundaries	• Governance	• Stakeholders
• Relationships	• Theory of Change	• Purposes
• Perspectives	• Intended Outcomes	• Methods

The worksheet's questions act as sensitizing concepts to consider in planning an evaluation, rather than as objective measures to be quantified and calculated. An evaluator can complete the worksheet alone or in a workgroup as part of an evaluation planning process. The answers outline the complexity of the system landscape in which the evaluator will be working. The three-part worksheet is not meant as a simple prescription for a system change evaluation design; the design is not meant to be the sum of the answers to the worksheet's questions. The three parts of the worksheet can also be completed in any order. An evaluator might start by identifying the overall goal or purpose of a system change evaluation, whereas program planners and managers might start with the system and intervention questions. The worksheet is meant to spur conversation among funders, managers, planners, and evaluators about the complexities of the system change intervention and its environment that need to be recognized and captured within the evaluation's design.

The first stage in this planning process is to identify the conditions and dynamics of the system or situation being addressed by the intervention.

The first stage in this planning process is to identify the conditions and dynamics of the system or situation being addressed by the intervention. This information will inform the scope of the evaluation and other design considerations.

Understand the Conditions and Dynamics of the Situation

In order to understand the conditions and dynamics of the system or situation targeted by a system change intervention, it is important to answer three sub-questions: (1) what are the *boundaries* of the system or situation? (2) how complex are the system's *relationships*? and (3) how diverse are the system's purposes or *perspectives*?

- *Identify the system's or situation's boundaries***.** A system boundary is not a physical entity as much as a sensitizing concept that sets the bounds of evaluation inquiry. *Boundaries* delineate what is inside or outside the situation of interest (Midgley 2007). They can refer to physical entities, organizational units, social systems, levels of government, or other demarcations of a whole and its parts. One way to determine a system's boundaries is to identify a problem of interest and to ask who or what is involved in addressing the problem, has influence on the problem, or is influenced by it (Checkland and Poulter 2006; Foster-Fishman et al. 2007). In simple, closed systems, boundaries are rigid. In open, dynamic systems, boundaries are more porous and may change in response to environmental or policy changes.

- *Determine complexity of the relationships. Relationships* are defined as the connections or exchanges that occur within and across system levels, and they can include flows of information, client referrals, staffing arrangements, funding streams, and sharing of other resources (Olson and Eoyang 2001). In simple situations, relationships are fixed, tightly coupled (dependent), and often hierarchical. Complicated system relationships can involve the coordination of separate entities, such as the use of multiple engineering teams in designing and building a large-scale construction project (Gawande 2010). Complex system relationships are more dynamic, loosely coupled (less dependent), and informal.
- *Note diversity of perspectives*. System stakeholders may have different perspectives or pursue different purposes within a given situation. They have different perspectives on the nature of the problem, on appropriate strategies for addressing the problem, or on implementation of those strategies. In simple systems, there is a high degree of certainty and agreement over system goals and how to achieve them; there is consensus on both desired ends and means (Stacey 1993). In complicated situations, there may be agreement on the overall purpose or goal of a system but less certainty on how to achieve it. For example, neighbors may come together to advocate for improved traffic safety but prefer a range of solutions, from sidewalks to stop signs. In complex situations, such as educational reform, there may be a great diversity of perspectives regarding both reform goals and strategies among the families, teachers, school administrators, education board members, state legislators, federal officials, and others involved in the issue.

There are several challenges . . . identifying appropriate system boundaries, capturing formal and informal system relationships, and addressing multiple perspectives.

There are several challenges to answering these questions, in terms of identifying appropriate system boundaries, capturing formal and informal system relationships, and addressing multiple perspectives. These challenges and potential solutions are discussed below.

Identifying appropriate boundaries. Without boundaries, the scope of a system change evaluation becomes unmanageable; it is not possible to change and evaluate everything. Boundaries that are too broad can overwhelm an intervention or evaluation. However, boundaries that are set too narrowly exclude important system perspectives and partners. At the same time, the identification of boundaries is somewhat arbitrary and needs to be critiqued in order to ensure that the boundaries selected match the complexity of the situation (Checkland and Poulter 2006; Williams and Imam 2007). For example, on the issue of tobacco control, smoking rights advocates argue that smoking is strictly a personal issue; people should be left alone to decide for themselves when and where to smoke. In contrast, health advocates argue that the boundaries of the issue should be expanded to protect the health of nonsmokers, particularly coworkers and family members who are involuntarily exposed to secondhand smoke.

To address this challenge, it is important to think carefully about a system's boundaries in order to assess the implications of those choices. The evaluator should work with funders, grantees, and other evaluation stakeholders to understand who may be included or excluded and who may win or lose politically by the choice of boundary criteria. Based on this review, the boundaries of inquiry should be adjusted to include all relevant stakeholders.

. . . it may be important to use system mapping and social network analysis techniques to capture and depict the interplay of relationships within a given situation, including the existence of networks.

During an evaluation's planning phase, qualitative data collection methods . . . can be used to gain a preliminary understanding of a situation and its dynamics, including identifying differences in perspectives among key players and organizations.

Capturing system relationships. Many kinds of formal and informal relationships can affect a given situation. Evaluations that focus only on official, hierarchical relationships may miss or understate the importance of less formal affiliations among system members. For example, in rural areas people may play many roles in their communities as neighbors, family members, childhood friends, school volunteers, churchgoers, and government officials. In those situations, a program administrator may draw on relationships and resources beyond a program's organizational boundaries to ensure its success. Evaluations that oversimplify the depiction of program relationships may miss vital factors that influence effective program implementation.

To address this challenge in complicated and complex systems, it may be important to use system mapping and social network analysis techniques to capture and depict the interplay of relationships within a given situation, including the existence of networks. Social network analyses are used to describe and visually display important network attributes, including the density, centrality, and cohesiveness of social networks (Barabasi 2002; Leischow et al. 2008; Borgatti et al. 2009). As relationships evolve, it may also be important to repeat system mapping and social network analyses periodically to capture ongoing changes in relationships in order to understand changes in conditions that may be affecting the implementation of a system intervention (Bloom and Dees 2008). For example, a critical event in an organization's environment, such as a change in the federal administration, could radically change policy and funding priorities across system levels, shifting the organization's network of alliances and destabilizing the organization. Such network changes would be displayed in a time series of network analyses.

Exploring multiple perspectives. Stakeholders' perspectives on a problem addressed by a system intervention may not be clear at the outset of an evaluation. Political, organizational, or personal agendas may be hidden or not yet clarified. The perspectives of particular subgroups may also be overlooked or not overtly expressed, especially if they differ from majority views. For example, research has found that without line staff buy-in and belief that a program will benefit its clients, social service program innovations are less likely to be implemented with fidelity (National Implementation Research Network 2009). Evaluations that solicit only the views of program managers and not those of line staff or clients may miss important information.

To address this challenge, a mixed-methods evaluation design may be appropriate. During an evaluation's planning phase, qualitative research methods, including literature reviews, environmental scans, and key informant interviews, can be used to gain a preliminary understanding of the situation and its dynamics, including identifying underlying differences in perspectives among key players or organizations. During later data collection, inclusion of different types of respondents will ensure that diverse perspectives are represented in the evaluation. For example, in evaluations of programs that serve non-English-speaking populations, care should be taken to translate interview materials and use bilingual site visit teams to interview clients about their experiences.

Understand the Elements and Dynamics of the Intervention

The second part of the three-part planning process is to identify the dynamics of the system intervention being evaluated. This involves identifying (1) the dynamics of the intervention's governance, (2) the dynamics of the intervention's theory of action or causal model, and (3) the diversity and specificity of the intervention's intended outcomes (Funnell and Rogers 2010; Patton 2010b).

- *Understand dynamics of the intervention's governance.* An intervention's governance may include its funding, management, organizational structure, and implementation. A simple intervention is typically implemented by a single agency or program, such as a stand-alone soup kitchen. More complicated efforts involve teams of experts or program units within an organization, such as the planning and implementation of standardized educational testing or the clearing of snow off local highways and city streets. Complex, networked interventions often involve the collaboration of multiple actors in multiple sectors at multiple levels. Examples include comprehensive public health initiatives addressing childhood asthma and obesity; prevention of child maltreatment; integrated urban development initiatives alleviating poverty; and networks of federal, state, and local agencies working together on homeland security (Kamarck 2007; Koball et al. 2009; Goldsmith and Kettl 2009).
- *Identify causal mechanisms.* In simple, straightforward interventions, linear logic models can be used to trace a stream of program inputs, activities, and outputs that lead to a small, specified set of outcomes. In more complicated interventions, multiple coordinated pathways may lead to a broader set of complementary outcomes. Complex system interventions may use complexity-based theories of action and change (Funnell and Rogers 2010). For example, in 2008 the World Health Organization piloted and evaluated the use of a two-minute surgery checklist to reduce surgical errors (Gawande 2010). Use of the checklist prevented simple mistakes, but it also created more complex adaptive conditions within the surgical teams that improved teamwork, communication, and information flow among team members, which enhanced their ability to respond successfully to unexpected surgical complications.
- *Analyze intervention's intended outcomes*. Simple, linear interventions are designed to produce specific, narrowly focused, and measurable outcomes, such as increasing client reading skills through a literacy program. Interventions with more complicated dynamics may target multiple, potentially conflicting outcomes, such as improving personal safety and independence for seniors in community-based, long-term care programs (Brown et al. 2008). In complex system interventions, stakeholders may share a common vision, such as reduced poverty at a regional level, improved quality of life for people with developmental disabilities, or rapid advances in biomedical science, but they may not be able to predict in advance which specific outcomes will emerge from the complex interactions of the system's actors (Moore 2010).

During the evaluation planning process, it is important to assess the potential stability of the system change intervention.

There are challenges to designing evaluations to address intervention-specific dynamics, in terms of evaluating evolving interventions, evaluating interventions that are misaligned with the dynamics of their situations or contexts, and monitoring unpredictable outcomes. These challenges and potential solutions are discussed below.

Evaluating evolving interventions. During the evaluation planning process, it is important to assess the potential stability of the system change intervention. Some evaluation designs, such as randomized controlled trials (RCTs), assume that an intervention will remain stable and unchanged for the evaluation's duration, potentially spanning several years. However, in volatile fiscal environments, grantees are vulnerable to sudden external changes in funding levels and priorities. If grant funds are cut unexpectedly, grantees must adapt, reducing or changing the services provided and potentially disrupting their RCT designs by reducing the contrast between treatment and control groups. Grant evaluators and program managers would then have to redesign their program's evaluation, including its RCT design. Also, some program interventions are not appropriate for random assignment evaluations, including entitlement programs or policies that apply to everyone, broadcast media campaigns, and "comprehensive, highly interactive social reforms that involve collective actions by multiple parties to foster community conditions that are expected to improve services" (U.S. Government Accountability Office 2009). Complex community initiatives focused on building civic and community capacity also require nonexperimental evaluation methods (Connell et al. 1999).

However, there are other effective evaluation designs that may work better in more fluid programs. To evaluate the effectiveness of such initiatives, the U.S. Government Accountability Office (GAO) has recommended the use of alternative designs, including quasi-experimental comparison groups, regression discontinuity analysis, interrupted time series analysis, observational or cross-sectional studies, and in-depth case studies (U.S. GAO 2009).

. . . it is important to identify potential misalignment of dynamics between the intervention and the system it is seeking to change.

Evaluating misaligned interventions. When system change interventions are based on causal models or theories of change that do not fit the dynamics of the situation, the mismatch can result in ineffective or counterproductive programs. During the evaluation planning process, it is important to identify potential misalignment of dynamics between the intervention and the system it is seeking to change. For example, simple, linear, one-dimensional initiatives such as "just say no" abstinence programs have been found ineffective in addressing the complex issues of teenage sexual activity and unprotected sex (Trenholm et al. 2008). Misreading of the dynamics of a situation can also lead to disastrous interventions. For example, Florida built a complicated emergency response command structure designed to respond specifically to hurricanes and tornadoes. Unfortunately, the system was not flexible or adaptive enough to cope with a record-breaking cold spell in January 2010, resulting in significant damage to the state's power grid, crops, wildlife, and residents (Gomez 2010). Failure to understand and anticipate complicated dynamics among system components can also lead to cascading failures, as occurred in NASA's 1986 Challenger and 2003 Columbia space shuttle disasters, when small failures in an O-ring and in some surface tiles escalated into complete destruction of the two space shuttles with multiple fatalities.

Linear logic models are not always appropriate for complicated and complex system intervention and evaluation designs, which should use theories of change and conceptual frameworks that match the complexity of the interventions' situations. Causal loop diagrams, ecosystem mapping, and participatory impact pathway analysis are more appropriate for complicated system change evaluations (Leischow et al. 2008; Sterman 2006; Bloom and Dees 2008; Douthwaite et al. 2008; Funnell and Rogers 2010). Simple rules (rules of thumb or guiding principles) and theories of adaptation, self-organization, and coevolution are more appropriate frameworks for designing complex system interventions (Holland 1995; Eoyang and Berkas 1998; Parsons 2007; Patton 2008; Hargreaves and Paulsell 2009).

Monitoring unpredictable outcomes. At the local, state, and federal levels, more government accountability systems are requiring the use of standardized, outcome-based performance measurement systems, such as the Program Assessment Rating Tool created by the Office of Management and Budget in compliance with the Government Performance

. . . in complicated or complex interventions or over long time frames, narrowly focused performance measures may miss some of the less-predictable processes and outcomes.

Results Act. In simple, uncomplicated situations or over relatively short time frames, performance measurement systems can accurately predict and track specified program processes and outcomes. But in complicated or complex interventions or over long time frames, narrowly focused performance measures may miss some of the less-predictable processes and outcomes.

To address this challenge, program monitoring systems can be adapted or updated on an ongoing basis to track evolving or surprising program processes and outcomes using adaptive learning systems (Kramer et al. 2009). Shared performance indicators can be reviewed and updated by a consortium of system partners as conditions change or as new patterns of system activity emerge. In programs with complicated dynamics or potentially conflicting goals (for example, safety versus independence for people with disabilities, jobs creation versus environmental protection for rural communities, and punishment versus rehabilitation for convicts), program performance indicators can be used to monitor tensions and trade-offs among outcomes. For complex interventions, backward engineering or retrospective evaluation techniques can also be used to identify, measure, and link program outcomes to activities after system changes have occurred (Patton 2010b).

Determine Users, Purposes, and Methods of the Evaluation

In the third part in the planning process, it is important to determine the intended users and purposes of the system change evaluation. An evaluation's intended users are its stakeholders—"individuals, groups, or organizations that affect or are affected by an evaluation process and/or its findings" (Patton 2008). An evaluation's purpose(s) can be to (1) support the development of an intervention (developmental evaluation), (2) improve an intervention (formative evaluation), (3) judge the value or worth of an intervention (summative evaluation), or (4) monitor the intervention's processes and outcomes for program management and accountability purposes (Patton 2008). A system change evaluation may be designed to achieve any or all of these purposes, in combination or in sequence. As interventions evolve and mature or as external conditions change, evaluation designs may be changed from developmental to formative and summative approaches. And, monitoring may be required by funders as a complement to other evaluation components.

After system and intervention dynamics are identified, the evaluation's intended users are identified, and the evaluation's goals are selected, there remain the challenges of identifying appropriate evaluation methods and translating systems theory into evaluation practice. To address multiple system dynamics, a mixed-methods approach is recommended. We explore and address these challenges below.

Aligning evaluation purposes, methods, and dynamics. Because systems theory has been introduced to the evaluation field only in the past 10 to 15 years, little has been written about how best to design and conduct system change evaluations. Traditional quantitative and qualitative research methods are being adapted for use in system change evaluations. In addition, new frameworks, models, and methods are being developed for evaluations of complicated and complex systems. Because evaluation designs depend on the kinds of evaluation questions asked as well as on the system conditions and dynamics, there is no one best design. The right design is one that addresses the evaluation's purpose(s) and captures the complexities of the intervention and its context.

TYPES OF SYSTEMS EVALUATION

Developmental evaluations are designed to support the development of new program models, the ongoing development of an intervention model, the adaptation of an intervention model to new dynamic environments; the development of a rapid response to a sudden change or crisis; or the evaluation of complex multilevel, multi-sector system change interventions. Typically, such evaluations involve a close, collaborative relationship in which the evaluator is part of the intervention team, providing reality testing and rapid feedback on activities relating to the intervention (Patton 2008). Developmental evaluations of system change initiatives can be used in simple, complicated, and complex contexts but are well suited for complex interventions that emphasize ongoing evolution and adaptation of intervention models in dynamic contexts. Systems thinking can contribute to developmental evaluation designs by capturing interactive adaptations of an intervention and its environment.

Formative evaluations are designed to improve the operation, implementation, or design of preexisting program models. Typically, such evaluations are conducted during the start-up or pilot phase of a program to confirm that the program model has been implemented as planned, identify the program's strengths and weaknesses, detect and correct any operational bugs, and determine whether participants are making appropriate progress toward the program's goals (Patton 2008). Traditionally used in simple and complicated situations, formative evaluations can be used in complex systems if the evaluation's design captures the system properties and dynamics of the intervention and situation. Systems thinking can contribute to formative designs by identifying any mismatch between the dynamics of an intervention's theory of change (how a particular change will come about) and its logic model or theory of action (what specifically the intervention will do to trigger the change process).

Summative evaluations are designed to judge the effectiveness, cost, sustainability, and merit or worth of a program so that funders and policymakers can make decisions regarding the continuation, scale-up, or termination of an intervention or program model. Typically, such evaluations are conducted by external evaluators after a program has become fully operational. Summative findings are also often used to verify that program resources have been managed appropriately to achieve the desired outcomes (Patton 2008). Traditionally used in simple situations, summative evaluations can be used in complicated and complex systems if the evaluation's design captures the system properties and dynamics of the intervention and situation. Systems thinking can contribute to summative designs by articulating, measuring, and testing the system dynamics in the intervention's causal model or theory of change.

Program monitoring and accountability evaluations are designed to monitor program processes and outcomes for program management, demonstrate that a program's resources are managed well, and attain intended results. Created for government- and funder-mandated reporting and continuous quality improvement requirements, these evaluations involve the tracking of program process and outcome measures through management information systems. Traditionally used in simple situations, program monitoring and accountability systems can be adapted for complicated and complex systems if they use "sentinel indicators" that capture the risk and complexity of the situation's dynamics (such as budget fluctuations or staffing changes); if, using an adaptive learning approach, the indicators are tied to the intervention's logic model or theory of action; and if the indicators are reviewed and updated periodically as the program evolves.

Table 1 provides a summary of the quantitative and qualitative research methods and approaches that are appropriate for each kind of system dynamic. Some qualitative methods including case studies, literature reviews, and reviews of program documentation are appropriate for all kinds of system and intervention dynamics. Other conceptual frameworks and methods have been designed specifically for complicated and complex systems:

- Qualitative research methods are well suited for *random, unorganized, or unknown system dynamics.* Useful approaches and methods include situation analyses, rapid assessments, environmental scans, needs assessments, mapping of community assets, case studies, interviews, and observations of system activities. The methods can help an evaluator assess the situation, informing the development or refinement of the rest of the evaluation's design.
- Many traditional research methods are best applied in situations with *simple, organized system dynamics.* Quantitative methods include randomized experiments, quasi-experimental comparisons, regression discontinuity analyses, hierarchical linear modeling, and performance measurement and monitoring systems. Qualitative methods include logic models, case studies, thematic content analyses, reviews of program documentation, and literature reviews. These methods make use of stable dynamics to track predicted change over time and to test counterfactual evidence.
- Some methods are designed for situations with *complicated dynamics.* Quantitative methods include stock and flow simulation modeling, causal loop simulation modeling, social network analyses, and interrupted time series analyses. Qualitative methods include causal loop diagrams, system mapping, ecosystem maps, participatory impact pathways analysis, case studies, thematic content analyses, reviews of program documentation, and literature reviews. These methods articulate and quantify the relationships between system parts and the impact of recursive, self-correcting, and self-reinforcing feedback between system parts on system outcomes.
- Some methods are designed for situations with *complex adaptive dynamics.* Appropriate quantitative methods include geographical information system (GIS) spatial analysis, agent-based modeling, time trend analyses, observational or cross-sectional studies, retrospective abductive analyses, and adaptive learning measurement systems. Qualitative methods include outcome mapping, case studies, analysis of emergent patterns of activity, appreciative inquiry, soft systems methods, reflective practice, and observational studies. Useful complexity-based conceptual models include simple rules and conditions of self-organization. These methods and models help evaluators identify changes in patterns of system behavior over time and space and understand the underlying conditions that contribute to such changes.

Translating systems theory into evaluation practice. Although systems theory and concepts have been incorporated into many disciplines since the 1950s, including biology, physics, cognitive science, management, and public health, the use of systems theory in the evaluation field is relatively new (Eoyang and Berkas 1998; Leischow et al. 2008). As a result, few evaluators are familiar with systems theory or are comfortable applying its concepts to their evaluation work. Those interested in learning more about systems may encounter a bewildering array of competing definitions, theories, frameworks, and methods. More work is needed to systematize and apply systems theory and methods to the evaluation field and to build systems knowledge and capacity among evaluators.

More work is needed to systematize and apply systems theory and methods to the evaluation field and to build systems knowledge and capacity among evaluators.

Table 1. System Dynamics and Evaluation Methods		
System Dynamics	**Quantitative Methods**	**Qualitative Methods**
Random Dynamics: • Random activity—no discernible pattern • Unconnected collection of parts • No detectable cause-effect relationships • No purpose or direction—people act independently, react blindly, or avoid action • Turbulence—no stability or equilibrium • Answers are unknowable		Case studies, interviews, and focus groups, observation of activities Mapping of community assets Environmental scans, Needs assessments Situational analyses One–time rapid assessments
Simple Dynamics: • Stable, static pattern • Parts tightly connected • Predictable cause-effect relationships • System can be reduced to parts and processes and copied or replicated as best practices • Directive leadership, designed change • Answers are knowable, obvious, prescriptions for action	Randomized experiments Quasi-experimental comparisons Regression discontinuity analyses Hierarchical linear modeling Performance measurement and monitoring Program audits and inspections	Case studies, interviews, and focus groups Thematic content analyses Purposive sampling of relevant cases Reviews of program documentation Literature reviews Logic models
Complicated Dynamics: • Dynamic patterns of feedback loops with many coordinated, interrelated parts within and across system levels • Cause and effect separated by time and space • Self-correcting feedback loops maintain equilibrium • Self-reinforcing feedback loops disrupt equilibrium • Answers are knowable through expert analysis	Computer simulation models of stocks, flows, and feedback Computer simulation models of causal loops Social network analyses Pre-post measurements of change Interrupted time-series analyses Comparative measurement and monitoring	Case studies, interviews, and focus groups Thematic content analyses Reviews of program documentation Literature reviews Causal loop diagrams, participatory impact pathways analysis System mapping, ecosystem maps
Complex Dynamics: • Dynamic patterns—parts adapting, coevolving with each other and environment • Parts are massively entangled and interdependent; nested webs and networks • System change emerges through interactions among parts; cause and effect are known in retrospect • Equilibrium is in flux, sensitive to initial conditions • Parts self-organize, learn, and change	GIS spatial analysis Agent-based modeling Time trend analyses Observational or cross-sectional studies Retrospective analyses Adaptive learning measurement systems	Case studies, interviews, and focus groups Observation of activities Document reviews Outcome mapping, concept mapping Analyses of emergent systemwide patterns, tracking of events, encounters, and policy changes Use of simple rules and conditions of self-organization Soft systems methodology Appreciative inquiry, reflective practice

Sources: Holland 1995; Eoyang and Berkas 1998; Snowden and Boone 2007; Leischow et al. 2008; Parsons 2007; Bloom and Dees 2008; Douthwaite et al. 2008; Kramer et al. 2008; Patton 2008; U.S. GAO 2009; Hargreaves and Paulsell 2009; Goldsmith et al. 2010; Patton 2010b; and Williams and Hummelbrunner 2010.

Although still early in its development, the application of systems theory to evaluation practice is an important advancement that can be used to enhance the development, improvement, and evaluation of system change interventions.

To address this challenge, more students need to be introduced to systems theory at all levels of their education, including graduate school, so that they can contribute to the development of the system change evaluation field. At a professional level, more systems evaluation–related workshops, seminars, and conference presentations are being provided through the American Evaluation Association and other professional research and evaluation groups. Early adopters are also organizing informal study groups, brown bag lunches, conference calls, and formal communities of practice to increase their knowledge and use of system concepts in evaluation. New books and journal articles on the topic are being published every year. A bibliography of resources is included at the end of this brief.

Final Considerations

This guide provided a quick introduction to the topic of system change evaluation planning and design. It included an overview of systems theory, a review of four kinds of system dynamics (random, simple, complicated, and complex), a three-part process for planning the evaluation of a system change intervention, and a listing of evaluation methods appropriate for each kind of system dynamic. The three-part planning process involves the following steps:

1. Understanding the conditions and dynamics of a system or situation, including how to identify appropriate system boundaries, capture system relationships, and explore multiple perspectives.

2. Identifying the elements and dynamics of a system intervention that can complicate an evaluation's design, including evaluating evolving interventions, evaluating misaligned interventions, and monitoring unpredictable outcomes.

3. Determining the intended users and purpose(s) of a system change evaluation; aligning evaluation purposes, methods, and dynamics; and translating systems theory into evaluation practice.

Funders, planners, managers, and evaluators can use this information to help guide the planning of system change evaluations. Although still early in its development, the application of systems theory to evaluation practice is an important advancement that can be used to enhance the development, improvement, and evaluation of system change interventions.

System Change Evaluation Planning Worksheet	
A. What is the situation?	
1. Describe the situation (its boundaries, parts, and whole).	
2. Describe the dynamics of the situation's relationships (random or unknown, simple, complicated, complex, or combination).	
3. Describe the diversity of the purposes or perspectives within the situation.	
B. What is the system change intervention?	
4. Describe the dynamics of the intervention's governance or implementation (random or unknown, simple, complicated, complex, or combination).	
5. Describe the dynamics of the intervention's theories of change and action (random or unknown, simple, complicated, complex, or combination).	
6. Describe the diversity and specificity of the intervention's intended outcomes.	
C. What are the goals of the system change evaluation?	
7. Describe the evaluation's users, purpose(s) (developmental, formative, summative, monitoring for accountability, and/or other), and methods.	

Source: Mathematica Policy Research.

Bibliography

Barabasi, Albert-Laszlo. *Linked: The New Science of Networks.* Cambridge, MA: Perseus Publishing, 2002.

Bloom, Paul, and Gregory Dees. 2008. *Cultivate Your Ecosystem*. Stanford Social Innovation Review, www.ssireview.org (accessed March 30, 2010).

Borgatti, Stephen P., Ajay Mehra, Daniel J. Brass, and Giuseppe Labianca. "Network Analysis in the Social Sciences." *Science*, vol. 323, February 13, 2009, pp. 892–895.

Brest, Paul, and Hal Harvey. *Money Well Spent: A Strategic Plan for Smart Philanthropy*. New York: Bloomberg Press, 2008.

Brown, Randall S., Carol V. Irvin, Debra J. Lipson, Samuel E. Simon, and Audra T. Wenzlow. "Research Design Report for the Evaluation of the Money Follows the Person (MFP) Grant Program." Final report submitted to the Centers for Medicare & Medicaid Services. Princeton, NJ: Mathematica Policy Research, October 3, 2008.

Brown Urban, Jennifer, and William Trochim. "The Role of Evaluation in Research Practice Integration Working Toward the 'Golden Spike.'" *American Journal of Evaluation,* vol. 30, no. 4, 2009, pp. 538-553.

Cabrera, Derek, Laura Colosi, and Claire Lobdell. "Systems Thinking." *Evaluation and Program Planning,* vol. 31, 2008, pp. 299–310.

Checkland, P. B. and J. Poulter. *Learning for Action: A Short Definitive Account of Soft Systems Methodology and Its Use for Practitioners, Teachers, and Students*. Chichester, U.K.: John Wiley, 2006.

Connell, James, Anne Kubisch, Lisbeth Schorr, and Carol Weiss (eds.). *New Approaches to Evaluating Community Initiatives: Concepts, Methods, and Contexts*. Queenstown, MD: Aspen Institute of Human Studies, 1999.

Crossover Health. March 2, 2009. *"Systemness": Which Delivery Model Is Best?* http://blog.crossoverhealth.com/2009/03/02/%E2%80%9Csystemness %E2%80%9D-which-delivery-model-is-best/ (accessed November 9, 2009).

Dorell, Oren, and Donna Leinwand. "Haiti Shattered by Chaos of Quake." *USA Today*, January 13, 2010, p. 1.

Douthwaite, Boru, Sophie Alvarez, Graham Thiele, and Ronald Mackay. May 2008. *Participatory Impact Pathway Anslysis: A Practical Method for Project Planning and Evaluation*. Institutional Learning and Change (ILAC) Brief 17, www.cgiar-ilac.org (accessed March 30, 2010).

Eoyang, Glenda. "Human Systems Dynamics: Complexity-based Approach to a Complex Evaluation." In *Systems Concepts in Evaluation: An Expert Anthology*, edited by Bob Williams and Iraj Imam. Point Reyes Station, CA: EdgePress. American Evaluation Association, 2007.

Eoyang, G.H., and T.H. Berkas. "Evaluation in a Complex Adaptive System." In *Managing Complexity in Organizations*, edited by Michael R. Lissack and Hugh P. Gunz. Westport, CT: Quorum Books, 1998.

Forrester, Jay Wright. "Counterintuitive Behavior of Social Systems." In *Collected Papers of Jay W. Forrester*, Chapter 14. Waltham, MA: Pegasus Communications, 1975.

Foster-Fishman, Pennie, Brenda Nowell, and Huilan Yang. "Putting the System Back into Systems Change: A Framework for Understanding and Changing Organizational and Community Systems." *American Journal of Community Psychology*, vol. 39, 2007, pp. 197–215.

Funnell, Sue, and Patricia Rogers. *Purposeful Program Theory: Using Theories of Change and Logic Models to Envisage, Facilitate, and Evaluate Change*. Forthcoming (2010).

Gawande, Atul. *The Checklist Manifesto: How to Get Things Right.* New York: Metropolitan Books, 2010.

Gladwell, Malcolm. *The Tipping Point: How Little Things Can Make a Big Difference.* New York: Little, Brown and Company, 2000.

Goldsmith, Stephen and William Eggers. *Governing by Network: The New Shape of the Public Sector*. Washington, DC: Brookings Institution, 2004.

Goldsmith, Stephen, Gigi Georges, and Tim Glynn Burke. *The Power of Social Innovation: How Civic Entrepreneurs Ignite Community Networks for Good*. San Francisco, CA: Jossey-Bass, 2010.

Goldsmith, Stephen and Donald Kettl (eds.). *Unlocking the Power of Networks: Keys to High-Performance Government.* Washington, DC: Brookings Institution, 2009.

Gomez, Alan. "Florida Fumbling with Freeze." *USA Today*, January 13, 2010, Nation Section.

Hargreaves, Margaret, and Jan Noga. "Systems, Systems Thinking, and Systemness: What's It All About, Anyway?" Professional development workshop presented at the American Evaluation Association Conference, Orlando, FL, November 15, 2009.

Hargreaves, Margaret, and Beverly Parsons. "Evaluating Complex System Interventions." Professional development workshop presented at the American Evaluation Association Conference, Orlando, FL, November 11, 2009.

Hargreaves, Margaret, Beverly Parsons, and Marah Moore. "Evaluating Complex Systems Initiatives." Professional development workshop presented for the National Institutes of Health Evaluation Set-Aside Program, Evaluation Office, Division of Program Coordination, Planning and Strategic Initiatives, Bethesda, MD, February 25–26, 2010.

Hargreaves, Margaret, and Diane Paulsell. "Evaluating Systems Change Efforts to Support Evidence-Based Home Visiting: Concepts and Methods." Washington, DC: Children's Bureau, Administration for Children and Families, U.S. Department of Health and Human Services, October 2009.

Hawe, Penelope, Lyndal Bond, and Helen Butler. "Knowledge Theories Can Inform Evaluation Practice: What Can a Complexity Lens Add?" *New Directions for Evaluation*, no. 124, Winter 2009.

Haynes, Alex B., Thomas G. Weiser, William R. Berry, Stuart R. Lipsitz, Abdel-Hadi S. Breizat, E. Patchen Dellinger, Teodoro Herbosa, Sudhir Joseph, Pascience L. Kibatala, Marie Carmela M. Lapitan, Alan F. Merry, Krishna Moorthy, Richard K. Reznick, Bryce Taylor, and Atul A. Gawande. "A Surgical Safety Checklist to Reduce Morbidity and Mortality in a Global Population." *The New England Journal of Medicine,* vol. 360, no. 5, January 9, 2009. Available at www.nejm.org.

Holland, John H. *Hidden Order: How Adaptation Builds Complexity*. Reading, MA: Helix Books, 1995.

Holland, John H. *Emergence: From Chaos to Order.* New York: Basic Books, 1998.

Johnson, S. *Emergence: The Connected Lives of Ants, Brains, Cities and Software.* New York: Penguin Books, 2001.

Kamarck, Elaine C. *The End of Government… As We Know It: Making Public Policy Work.* Boulder, CO: Lynne Rienner Publishers, 2007.

Kane, Mary and William Trochim. *Concept Mapping for Planning and Evaluation*. Thousand Oaks, CA: Sage Publications, 2007.

Kauffman, Stuart. *At Home in the Universe: The Search for the Laws of Self-Organization and Complexity*. New York and Oxford, England: Oxford University Press, 1995.

Kelso, J. A. Scott. *Dynamic Patterns: The Self-Organization of Brain and Behavior.* Cambridge, MA: MIT Press, 1995.

Kim, Daniel H. *Introduction to Systems Thinking*. Waltham, MA: Pegasus Communications, Inc., 1999.

Koball, Heather, Heather Zaveri, Kimberly Boller, Deborah Daro, Jean Knab, Diane Paulsell, Margaret Hargreaves, Debra A. Strong, Lizabeth Malone, Patricia Del Grosso, and Yange Xue.

"Cross-Site Evaluation of the Supporting Evidence-Based Home Visiting Grantee Cluster: Evaluation Design Volume 1." Washington, DC: Children's Bureau, Administration for Children and Families, U.S. Department of Health and Human Services, 2009.

Kramer, Mark, Marcie Parkhurst, and Lalitha Vailyanathan. July 2009. *Breakthroughs in Shared Measurement and Social Impact*. FSG Social Impact Advisors, , www.fsg-impact.org (accessed March 30, 2010).

Lavinghouze, S. René, Ann W. Price, and Beverly Parsons. "The Environmental Assessment Instrument: Harnessing the Environment for Programmatic Success." *Health Promotion Practice*, vol. 10, no. 2, 2009, pp. 176–185. Thousand Oaks, CA: Sage Publication.

Leischow, Scott, Allen Best, William Trochim, Pamela Clark, Richard Gallagher, Stephen Marcus, and Eva Matthews. "Systems Thinking to Improve the Public's Health," *American Journal of Preventive Medicine,* vol. 35, no. 2S, 2008, pp. S196–S210.

Living Cities. "Request for Full Proposals: National Evaluators of the Integration Initiative." Living Cities: The Integration Initiative, 2010.

Mabry, Patricia L., Deborah H. Olster, Glen D. Morgan, and David B. Abrams. "Interdisciplinarity and Systems Science to Improve Population Health: A View from the NIH Office of Behavioral and Social Sciences Research." *American Journal of Preventive Medicine*, vol. 35, no. 2S, 2008, pp. S211–S224.

Meadows, Donella H. *Leverage Points: Places to Intervene in a System*. Hartland, VT: The Sustainability Institute, 1999.

Meadows, Donella H. *Thinking in Systems.* White River Junction, VT: Chelsea Green Publishing Company, 2008.

Midgley, Gerald. *Systems Thinking.* Thousand Oaks, CA: Sage, 2003.

Midgley, Gerald. "Systems Thinking for Evaluation." In *Systems Concepts in Evaluation: An Expert Anthology,* edited by Bob Williams and Iraj Imam. Point Reyes, CA: American Evaluation Association, 2007.

Miller, John H., and Scott E. Page. *Complex Adaptive Systems: An Introduction to Computational Models of Social Life* . Princeton, NJ: Princeton University Press, 2007.

Moore, Marah. Personal correspondence, February 5, 2010.

National Cancer Institute. *Greater Than the Sum: Systems Thinking in Tobacco Control.* Tobacco Control Monograph No. 18. Bethesda, MD: U.S. Department of Health and Human Services, National Institutes of Health, National Cancer Institute. NIH Pub. No. 06-6085, April 2007.

National Implementation Research Network (NIRN). "Implementing Evidence-Based Practices: Experiences of the 2007 and 2008 Science and Service Award Recipients," Chapel Hill, NC: University of North Carolina, February 2009.

Olson, Edwin E., and Glenda H. Eoyang. *Facilitating Organization Change: Lessons from Complexity Science*. San Francisco, CA: Jossey-Bass/Pfeiffer, 2001.

Osgood, Nathaniel. *Basics of Causal Loop Diagrams: Structure & Behavior*. Saskatoon, SK: University of Saskatchewan Institute for System Science & Health, 2009.

Parsons, Beverly. "Designing Initiative Evaluation: A Systems-Oriented Framework for Evaluating Social Change Efforts." W.K. Kellogg Foundation, September 2007.

Patton, Michael Q. *Utilization-Focused Evaluation.* 4th ed. Thousand Oaks, CA: Sage Publications, 2008.

Patton, Michael Q. Personal correspondence, February 10, 2010a.

Patton, Michael Q. *Developmental Evaluation: Enhancing Social Innovation and Use in Complex Systems*. New York: Guilford Press, 2010b.

Preskill, Hallie and Tessie Tzavaras Catsambas. *Reframing Evaluation Through Appreciative Inquiry.* Thousand Oaks, CA: Sage Publications, 2006.

Prigogine, Ilya. "The Philosophy of Instability." *Futures,* vol. 11, no. 4, August 1989, pp. 396–400.

Ramage, Magnus, and Karen Shipp. *Systems Thinkers.* London, UK: Springer, 2009.

Research and Training Center for Children's Mental Health, 2009. "Case Studies of System Implementation Issue Brief # 2," http://rtckids.fmhi.usf.edu/cssi/default.cfm (accessed November 11, 2009).

Research and Training Center for Children's Mental Health, 2009.. "Systems of Care Definition: Issue Brief # 1," http://rtckids.fmhi.usf.edu/rtcpubs/ study02/ IssueBrief1Definition.pdf (accessed November 11, 2009).

Rogers, Everett. *Diffusion of Innovations.* 5th ed. New York: Free Press, 2003.

Senge, Peter M. *The Fifth Discipline: The Art and Practice of the Learning Organization.* New York: Currency Doubleday, 1990.

Snowden, David J., and Mary E. Boone. "A Leader's Framework for Decision Making." *Harvard Business Review*, November 2007, pp. 1–9.

Stacey, Ralph. *Strategic Management and Organizational Dynamics: The Challenge of Complexity.* Essex, England: Financial Times Prentice Hall, 1993.

Sterman, John. "Learning from Evidence in a Complex World." *American Journal of Public Health,* vol. 96, no. 3, March 2006, pp. 505–514.

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

Trenholm, Christopher, Barbara Devaney, Kenneth Fortson, Melissa Clark, Lisa Quay, and Justin Wheeler. "Impacts of Abstinence Education on Teen Sexual Activity, Risk of Pregnancy, and Risk of Sexually Transmitted Diseases." *Journal of Policy Analysis and Management*, vol. 27, no. 2, 2008, pp. 255–276.

Trochim, William, D. Cabrera, Bobby Milstein, R. Gallagher, and S. Leischow. "Practice Challenges in Systems Thinking and Modeling in Public Health." *American Journal of Public Health,* vol. 96, no. 5, 2006, pp. 538–546.

U.S. Government Accountability Office. "Program Evaluation: A Variety of Rigorous Methods Can Help Identify Effective Interventions." Report to Congressional Requesters, GAO-10-30. U.S. GAO, November 2009.

von Bertalanffy, Ludwig. "General Systems Theory." *Main Currents in Modern Thought,* vol. 11, 1955, pp. 75–83.

Westley, Frances, Brenda Zimmerman, and Michael Quinn Patton. *Getting to Maybe: How the World Is Changed*. Toronto, Ontario, Canada: Random House Canada, 2006.

Wheatley, Margaret. *Leadership and the New Science*. San Francisco, CA: Berrett-Koehler Publishers, 2001.

Williams, Bob, and Iraj Imam (eds.). *Systems Concepts in Evaluation: An Expert Anthology*. Point Reyes, CA: American Evaluation Association, 2007.

Williams, Bob, and Richard Hummelbrunner. *Systems Concepts in Action: A Practitioner's Toolkit*. Forthcoming (2010).

Zimmerman, Brenda, Curt Lindberg, and Paul Plsek. *Edgeware: Insights from Complexity Science for Health Care Leaders.* Irving, TX: VHA Inc., 1998.

About the Author

Margaret Hargreaves is a senior researcher at Mathematica Policy Research with 20 years of experience in planning, managing, and evaluating public health, health care, and social service programs addressing racial and ethnic health disparities. Her work has included many collaborative system change initiatives and programs targeting underserved populations, including racial/ethnic minorities, low-income populations, rural communities, and people living with HIV/AIDS. She also has a wide range of methodological expertise in qualitative methods (interviews, focus groups, and case studies), surveys, evaluation technical assistance, and complex system change evaluations. Hargreaves is program cochair of the Systems in Evaluation Topical Interest Group of the American Evaluation Association, an associate of the Human Systems Dynamics Institute, and a member of the American Public Health Association. She has a Ph.D. in health policy and evaluation (health disparities) from the Union Institute and University and an M.P.P. in social welfare policy from the Harvard Kennedy School of Government.

About Mathematica®

Mathematica Policy Research, a nonpartisan research firm, provides a full range of research and data collection services, including program evaluation and policy research, survey design and data collection, research assessment and interpretation, and program performance/data management, to improve public well-being. Its clients include federal and state governments, foundations, and private-sector and international organizations. The employee-owned company, with offices in Princeton, N.J., Ann Arbor, Mich., Cambridge, Mass., Chicago, Ill., Oakland, Calif., and Washington, D.C., has conducted some of the most important studies of family support, nutrition, health care, international, disability, education, employment, and early childhood policies and programs.

Improving public well-being by conducting high-quality, objective research and surveys

Princeton, NJ ▪ Ann Arbor, MI ▪ Cambridge, MA ▪ Chicago, IL ▪ Oakland, CA ▪ Washington, DC

MATHEMATICA Policy Research, Inc.

www.mathematica-mpr.com