Harnessing Operational Systems Engineering to Support Peacebuilding: Report of a Workshop by the National Academy of Engineering and United States Institute of Peace Roundtable on Technology, Science, and Peacebuilding

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Andrew Robertson and Steve Olson, Rapporteurs; National Academy of Engineering; United States Institute of Peace

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Andrew Robertson and Steve Olson, *Rapporteurs*

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Although the reviewers listed above provided many constructive comments and suggestions, they were not asked to endorse the views expressed in the report, nor did they see the final draft of the report before its release. The review of this report was overseen by Venkatesh (Venky) Narayanamurti, Benjamin Peirce Professor of Technology and Public Policy, Harvard School of Engineering and Applied Science, and director, Science, Technology and Public Policy Program, Harvard Kennedy School. Appointed by NAE, he was responsible for making certain that an independent examination of this report was carried out in accordance with institutional procedures and that all review comments were carefully considered. Responsibility for the final content of this report rests entirely with the authors and NAE.

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1

Introduction and Themes of the Workshop

Operational systems engineering is a methodology that identifies the important components of a complex system, analyzes the relationships among those components, and creates models of the system to explore its behavior and possible ways of changing that behavior. In this way it offers quantitative and qualitative techniques to support the design, analysis, and governance of systems of diverse scale and complexity for the delivery of products or services.

Many peacebuilding interventions function essentially as the provision of services in response to demands elicited from societies in crisis. At its core, operational systems engineering attempts to understand and manage the supply of services and product in response to such demands. Thus, the question before the workshop was "When can operational systems engineering, appropriately applied, be a useful tool for improving the elicitation of need, the design, the implementation, and the effectiveness of peacebuilding interventions?"

On November 20, 2012, the Roundtable on Science, Technology, and Peacebuilding (Box 1-1) of the National Academy of Engineering (NAE) and the United States Institute of Peace (USIP) sponsored a workshop to explore this question. The workshop convened experts in conflict prevention, conflict management, postconflict stabilization, and reconstruction along with experts in various fields of operational systems engineering for a day of invigorating, multidisciplinary discussion.

Box 1-1
The Roundtable on Science, Technology, and Peacebuilding

The Roundtable on Science, Technology, and Peacebuilding is a joint initiative of the National Academy of Engineering and the US Institute of Peace. Its membership consists of senior executives and experts from government agencies, universities, corporations, and nongovernmental organizations (NGOs). The Roundtable was established in 2011 to make a measurable and positive impact on conflict management, peacebuilding, and security capabilities by bringing together leaders from the technical and peacebuilding communities. Its principal goals are:

1. To accelerate the application of science and technology to the process of peacebuilding and stabilization.
2. To promote systematic, high-level communication between peacebuilding and technical organizations on the problems faced in and the technical capabilities required for successful peacebuilding.
3. To collaborate in applying new science and technology to the most pressing challenges faced by local and international peacebuilders working in conflict zones.

The Roundtable has sponsored four workshops. The first examined how agricultural extension systems might be adapted to serve the purposes of peacebuilding. The second addressed the role of data sharing to improve coordination in peacebuilding, and the third investigated the use of information and communication technologies to sense and shape emerging conflicts. The fourth workshop, the subject of this summary report, focused on harnessing operational systems engineering to support peacebuilding.

Workshop co-chair Peter Cherry, an independent consultant and retired analyst and executive from Science Applications International Corporation (SAIC), noted that the peacebuilding and engineering communities often use different concepts, methods, and even vocabularies, yet they need to understand each other to work on shared problems. Achieving such understanding requires both a willingness to consider new perspectives and an acknowledgment of the complexity of peacebuilding goals. As Sam Worthington, president and CEO of InterAction and the other workshop co-chair, added,

"Any peacebuilding effort ultimately is based on multiple stakeholders coming together in very complex environments."

Some peacebuilders have already adopted elements of systems approaches in developing frameworks and qualitative techniques to understand peacebuilding and provide support to planning and decision making. Most project implementation organizations collect data but focus on specific issues immediately related to the project. Legitimate concerns about data privacy and security limit more widespread sharing and use of information. Similarly, most peacebuilders generate and use metrics to assess and measure progress, but these are not, in the context of systems engineering, complete, consistent, or independent. This workshop thus had as a goal the initiation of a dialogue between peacebuilders and operational systems engineers to begin to identify what additional types of nonnumerical systems methods might be available for application to peacebuilding. The workshop steering committee intended that the day's agenda would create opportunities for further development and application of quantitative operational systems engineering methods to peacebuilding by initiating discussions on the collection and use of data, the development of numerical models, and the construction and use of metrics. Specific solutions to particular problems were not the goal of the workshop.

To provide a starting point for this dialogue, the workshop began with three presentations by peacebuilders, showing the diverse challenges faced and approaches adopted to meet those challenges, thus giving the operational systems engineers an initial understanding of the peacebuilding "system." Two perspectives of systems engineering were then delivered, the first showing the development and use of quantitative data, models, and metrics, and the second demonstrating a qualitative application of systems methods. Both addressed the process employed in data specification and collection, model development and use, and the construction and application of metrics aimed at providing peacebuilders with an understanding of the Operational Systems Engineering discipline. The dialogue that began in the initial presentations was then focused and expanded in three workgroups in which peacebuilders and systems engineers explored the potential application of systems engineering to specific peacebuilding initiatives.

Peacebuilding can be defined as a social transformation designed to build institutions that manage conflict without resorting to violence. To do this, reforms may target a broad range of sectors including economics, security, the judiciary, social institutions, and government. It is a highly politicized and complex process that transforms power structures, broadens participation, and often requires a renegotiation of how citizens relate to

their national institutions. Conflict is present in war and in peace. It is an inevitable aspect of human interaction when two or more parties pursue mutually incompatible goals. Conflict settled by violence is war, but conflict can be settled peaceably through elections or an adversarial legal process. In planning the workshop, it was hypothesized that systems engineering is relevant to managing this process of social transformation. Systems engineering may enable more effective planning, coordination, management, and evaluation of peacebuilding activities by deploying a structured development process that identifies needs, functionality, and requirements for success as stakeholders proceed from concept to design to operation.[1]

ORGANIZATION OF THE WORKSHOP

The workshop began with two plenary sessions featuring formal presentations, which are summarized in the next two chapters. Chapter 2 describes the characteristics of peacebuilding, a framework for conflict assessment, and approaches to managing conflicts. Chapter 3 explores the potential applications of operational systems engineering to peacebuilding, looking at both quantitative and qualitative approaches.

After the plenary sessions, workshop participants divided into three breakout groups designed to develop systems-based methods to generate solutions to the problems facing peacebuilders in three fragile societies: Kenya, South Sudan, and Haiti. Chapters 4–6 summarize the breakout groups' presentations and discussions and the reports that followed. The goal of these breakout sessions was not to develop particular solutions to a problem faced by each of these societies but rather to develop methods that could be deployed to develop a solution. Box 1-2 lays out what the generic elements of a method might be. If sufficient interest were generated, groups were asked to organize follow-on activity to begin implementation of the work plans that they developed.

In the final plenary session, workshop participants identified lessons learned from the day's discussions and broad paths forward for applying operational systems engineering to improve the effectiveness of peacebuilding. These discussions are summarized in Chapter 7.

[1] "Glossary of Terms for Conflict Management and Peacebuilding," United States Institute of Peace, http://glossary.usip.org/resource/peacebuilding; http://glossary.usip.org/resource/conflict; "What Is Systems Engineering," International Council on Systems Engineering, http://www.incose.org/practice/whatissystemseng.aspx.

Box 1-2
Elements of a Systems-Based Analysis

Each working group was asked to design a method for future systems engineering activities to investigate the major challenges facing peacebuilders in one of the three conflict zones addressed during the breakout session. Chairs in each breakout session were asked to ensure that discussion addressed the following key areas:

- Objectives
- Possible Technical Approach(es)
  - modeling,
  - network analysis,
  - analysis of operational data,
  - experimentation, etc.
- Expertise and Perspectives Needed
- Decision Alternatives or Other Variables
- Assumptions
  - data availability,
  - future demand, etc.
- Data Needs
- Metrics
  - performance,
  - outcomes,
  - effectiveness
- Expected Analysis Outputs or Deliverables
  - process changes,
  - resource allocation changes, etc.
- Suggested actions needed to implement analysis plans and improve peacebuilding service delivery.

THEMES OF THE WORKSHOP

The following themes emerged from the presentations and discussions during the workshop.

Operational Systems Engineering May Support Better Management of Peacebuilding

Participants acknowledged the complexity and challenges of peacebuilding. Interdependencies and relationships are numerous, at times convoluted,

and often not completely understood. Data can be difficult to collect, are not always precise, accurate, or complete, and frequently are proprietary. All "solutions" must be situation specific, and local buy-in and ownership are critical to long-term success. And, as Sam Worthington noted, "We have to be talking at multiple levels, from the field level all the way up to the overall policy level for a particular country." Given this context, many argued that operational systems engineering could make significant contributions to the effectiveness and efficiency of peacebuilding and that the complexity and challenges of the peacebuilding process need not be barriers to successful applications.

Initial Applications of Systems Methods Have Demonstrated Value

Peacebuilders have begun to use systems methods primarily to identify actors, the relationships between them, and the conditions that influence those relationships. The workshop's breakout groups allowed participants to begin considering how to identify such actors, relationships, and conditions in the context of an ongoing conflict. To help peacebuilders perform such analyses, the development of tools, techniques, and training would be beneficial. Andrew Reynolds of the State Department noted that "the full range of actors needs to be identified and incorporated into systems analyses, not just NGOs and governments but also the many other parts of societies that influence the outcomes of peacebuilding." Systems maps are useful tools in such analyses. They enable the visualization of causal relationships between variables in a system by graphically linking activities that affect each other.[2] From the perspective of the operational systems engineers, systems maps and related techniques can be used throughout the engineering process to identify critical relationships and data requiring greater detail and analysis. From the perspective of the peacebuilders, the act of constructing a systems map can lead to better understanding of the situation, the risks, and the potential outcomes of proposed actions.

[2] Robert Ricigliano, *Making Peace Last: A Toolbox for Sustainable Peacebuilding* (Boulder, CO: Paradigm Publishers, 2012), 112.

Applications of Operational Systems Engineering to Peacebuilding Will Evolve

The methods of operational systems engineering can be brought to bear on a problem whether data are ample or scarce by using the appropriate tools. The full power of the systems approach will be realized as the range and nature of the methods used expands. As Robert Ricigliano, University of Wisconsin–Milwaukee put it, "Peacebuilding needs to move beyond constructing maps of causal relationships to developing and elaborating models for analysis and design that are continually improved through data gathering and hypothesis testing." Beth Cole, USAID, observed that systems methods will also require peacebuilders to become more process-oriented, adding that "the fact of the matter is there are gaps [in our understanding of how to realize particular goals] and we have to attend to those if we want to try and address peacebuilding in a systemic approach." Bill Rouse, Stevens Institute of Technology, illustrated the application of more quantitative methods and the potential for deriving data development priorities from quantitative models, supplementing and enlarging on the understanding gained from the qualitative systems maps. All agreed that the initial steps in a systems approach—involving differentiation of functions, identification of actors, and specification of relationships and effects—have inherent value both through the insights they provide and the collaboration and communication they produce between stakeholders and operational systems engineers.

Time Invested in Modeling Has a High Payoff

To apply operational systems engineering successfully to peacebuilding will require close collaboration between peacebuilders and systems engineers. Peacebuilders understand the conflict and are working to develop a response to a crisis; the systems engineers can develop a model (or models) to understand the dynamics of the situation, assess risks and outcomes, and evaluate possible interventions through analysis. Frequently, this requires that multiple simulations be made to understand a range of possibilities. Steven Robinson, University of Wisconsin–Madison, observed that "a range of outcomes with probabilities attached to each is often more useful than a single outcome." To produce such insight will require iterative development of a model with extensive back-and-forth between the modelers and the peacebuilders. This is potentially quite time consuming, but experience applying systems engineering across a broad range of domains confirms that this process of model building ultimately has a high payoff.

One approach to cope with this complexity is to begin with simpler, bounded problems (subsystems) and then build out, adding actors and relationships to include additional subsystems until all relevant effects are modeled. Marvine Hamner, George Washington University, put it succinctly: "You start simple . . . and you add complexity." This approach is manageable, allows for checking model validity, and can produce usable results early in the process.

Focusing on Specifics Is Critical

The workshop demonstrated that the value of operational systems engineering was most apparent when specific situations were considered. All three of the breakout groups emerged from their discussions with suggestions for specific projects that could respond to challenges and take advantage of opportunities. Understanding and influencing specific situations is consistent with the goals and missions of most peacebuilders, because each situation has its own key attributes and differences. Lessons that can be applied more broadly will emerge, but a local, specific focus and local buy-in are essential.

Institutional Capacity to Use Systems Engineering in Peacebuilding Must Be Expanded

At present, the peacebuilding community has only limited capacity to use systems engineering as a tool to realize its ends. If this is to change, both individual skills and organizational management must be enhanced. Andrew Reynolds remarked that "programs and curricula in colleges and universities need to be reshaped to provide students with the tools and concepts necessary to apply systems analysis to complex societal problems." Thus, efforts should be made to include systems engineering in programs that address the practice of peacebuilding at levels from field operations to the funding, direction, and management of provider organizations.

In addition to these themes, participants expressed support for future workshops such as this, but with a finer focus and an expanded set of participants.

2

Characteristics of Peacebuilding

In the first workshop session, "Understanding Peacebuilding: Three Perspectives," Beth Cole, director of the Office of Civilian-Military Cooperation at the US Agency for International Development (USAID), presented an analysis of the broad components shared by peacebuilding missions. Next, Kirby Reiling, conflict specialist with USAID's Office of Conflict Management and Mitigation, outlined a framework developed by USAID to assess conflicts so that interventions can be targeted and evaluated. Finally, Sharon Morris, director of youth and conflict management for Mercy Corps, explained how her organization seeks to manage conflicts. All three speakers provided an overview of what peacebuilding entails; the major concerns, issues, and decisions facing peacebuilders at different levels; and the complexity of the environments within which peacebuilders have to make decisions and operate.

Importantly, each presentation offered a different perspective on the peacebuilding process. Cole provided a holistic, integrated approach to support peace, stability and development at the country-level. The USAID presentation and framework by Reiling was also a national-level approach, although the same framework could be applied regionally or in particular sectors. Morris's description of Mercy Corps's experience describes peacebuilding at the project level with substantially more limited goals—not peace or stability in the overall country, but incremental improvements in people's security, freedom of movement, or trust in government institutions.

COMPONENTS OF PEACEBUILDING

In 2009, USIP and the US Army Peacekeeping and Stability Operations Institute released the report *Guiding Principles for Stabilization and Reconstruction*, laying out the broad characteristics of peacebuilding missions that operational systems engineering could be used to analyze.[1] USAID's Beth Cole described the report as the product of an effort to create the equivalent of a military doctrine for organizations that work to bring peace to societies emerging from conflict.

Cole and the other authors of the report drew from the experiences of organizations and individuals involved in peacebuilding and from more than 1,000 documents on various aspects of peacebuilding. They identified patterns, drew lessons, and synthesized broadly shared principles for peacebuilding activities. The report identifies five broad goals, or end states (below), for peacebuilding missions, along with 22 conditions needed to achieve them (Figure 2-1).

Safe and Secure Environment: Ability of the people to conduct their daily lives without fear of systematic or large-scale violence.

Rule of Law: Ability of the people to have equal access to just laws and a trusted system of justice that holds all persons accountable, protects their human rights, and ensures their safety and security.

Stable Governance: Ability of the people to share, access, or compete for power through nonviolent political processes and to enjoy the collective benefits and services of the state.

Sustainable Economy: Ability of the people to pursue opportunities for livelihoods in a system of economic governance bound by law.

Social Well-Being: Ability of the people to be free from want of basic needs and to coexist peacefully in communities with opportunities for advancement.

The report also lists seven cross-cutting principles which, together with the end states and conditions, form a strategic framework for stabilization and reconstruction (S&R). The principles apply to every actor and every end state and are focused on outcomes.

[1] USIP and the US Army Peacekeeping and Stability Operations Institute. 2009. *Guiding Principles for Stabilization and Reconstruction.* Washington: USIP.

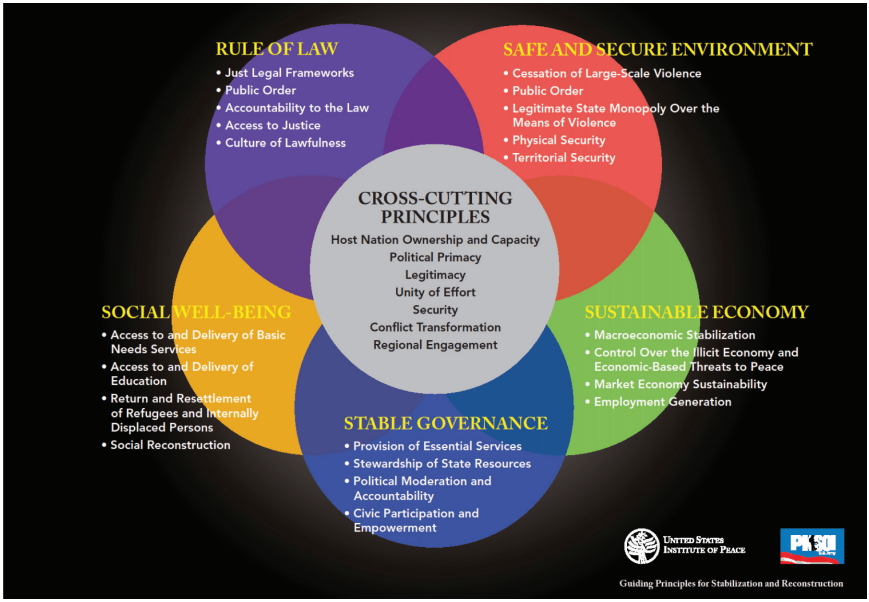

FIGURE 2-1 Guiding Principles for Stabilization and Reconstruction describes five broad goals (end states) and 22 conditions needed to achieve them along with seven cross-cutting principles (in the center circle) that apply to all of the goals. The goals are depicted as overlapping circles to emphasize the interdependence of the principles and the linkages among them. SOURCE: USIP, Cole workshop presentation.

The principle of ***host-nation ownership and capacity*** requires the affected country to drive its own development needs and priorities even if transitional authority is in the hands of outsiders. Ownership requires capacity, which often needs tremendous strengthening in S&R environments.

Political primacy demands that a political settlement be the cornerstone of a sustainable peace. Every decision and every action has an impact on the possibility of forging political agreement.

Legitimacy has three facets: the degree to which (1) the host-nation population accepts the mission and its mandate or the government and its actions; (2) the government is accountable to its people; and (3) regional neighbors and the broader international community accept the mission mandate and the host-nation government.

Unity of effort begins with a shared understanding of the conditions. It refers to cooperation toward common objectives over the short and long

term, even when the participants are from many different organizations with diverse operating cultures.

Security is a cross-cutting prerequisite for peace and creates the enabling environment for development. The lack of security is what prompts an S&R mission to begin with.

Conflict transformation guides the strategy to transition from violent to peaceful means of conflict resolution. It requires reducing drivers and strengthening mitigators of conflict across political, security, rule of law, economic, and social spheres, while building the host nation's capacity to manage political and economic competition through peaceful means.

Regional engagement entails encouraging the host nation, its neighboring countries, and other key states in the region to partner in promoting both the host nation's and the region's security and economic and political development. It has three components: comprehensive regional diplomacy, a shared regional vision, and cooperation.

The five goals focus on the *what*, not the *who*, of peacebuilding, Cole emphasized, and in that respect are less complex than actual peacebuilding operations, which bring in a broad array of actors with diverse objectives and motivations. Nevertheless, the systematic framework for peace presented in *Guiding Principles for Stabilization and Reconstruction* is both aspirational and practical, presenting approaches that can be used to achieve each of the 22 conditions. The guide is being widely used, not just in courses for peacebuilders but in the field.

Cole acknowledged, however, that, in working toward the end states, tradeoffs are inevitable. For example, drilling a well in a community, while serving the goal of improved social well-being, may at the same time give rise to conflict because not all groups in the community have equal access. As another example of a tradeoff often seen in peacebuilding, she explained that bringing a warlord into government could end a violent regional conflict but at the same time undermine the legitimacy of the government at the national level. Understanding tradeoffs using a systems approach can guide the development of a strategy that reduces (but, she cautioned, cannot eliminate) the negative consequences of tradeoffs.

In assessing the five goals defined in this framework, the analyst must identify gaps and challenges in the steps needed to achieve them. Gaps are weaknesses in knowledge, and challenges are shortfalls in practice even after best practices have been identified. She cited the rebuilding of education systems after conflict as an example of a difficult gap. "We can build the schools,

but we don't know how to put teachers in them, and we don't know what curriculum they should be teaching. It's an enormous problem." Similarly, reform of the security sector has not been done well anywhere, according to Cole, even when the basic principles of doing so are known.

Coherent peacebuilding strategies require attention to all of the conditions and end states, not just a few, Cole emphasized. The interdependencies among the goals must be addressed to generate stable solutions. For example, in dealing with the youth militias that often proliferate during civil war, a security sector program of disarmament, demobilization, and reintegration will not be sufficient. Changes to the legal code may also be required. Programs to retrain demobilized youth and provide economic opportunities will be necessary, as will community-level intervention to support reconciliation and development to foster a sense of social well-being and achieve sustainable peace. In short, Cole said, "it is a tiger team approach."

A FRAMEWORK FOR CONFLICT ASSESSMENT

The vast majority of conflicts since World War II have been *intrastate* conflicts, said USAID's Kirby Reiling.[2] As of the end of 2011, 37 countries were in armed conflict, according to the Uppsala Conflict Data Program (www.pcr.uu.se/research/UCDP/), and several more were recovering from recently terminated armed conflicts.

Armed conflict and political instability can take a range of forms, such as insurgencies, coups d'état, intercommunal violence, violent extremism and terrorism, and crime. Over half of USAID's funding goes to countries affected by or recovering from conflict, requiring that the agency consider the interaction between conflict and development.

To inform their programming, most development agencies like USAID have created conflict assessment frameworks, which define a systematic process to analyze and prioritize the dynamics of peace and conflict in a given country. These frameworks are designed to help agencies and their partners formulate strategies, develop policies, and design programs to prevent, mitigate, and manage conflict. Although these frameworks were not created specifically using the methods of systems engineering, they provide an example of how the development of strategies for peacebuilding are becoming more structured and more principled and how peacebuilding as a field is moving toward a more systems-oriented approach to strategy development.

[2] The views and opinions expressed by Kirby Reiling during his presentation and summarized here reflect only his perspective, not necessarily that of USAID.

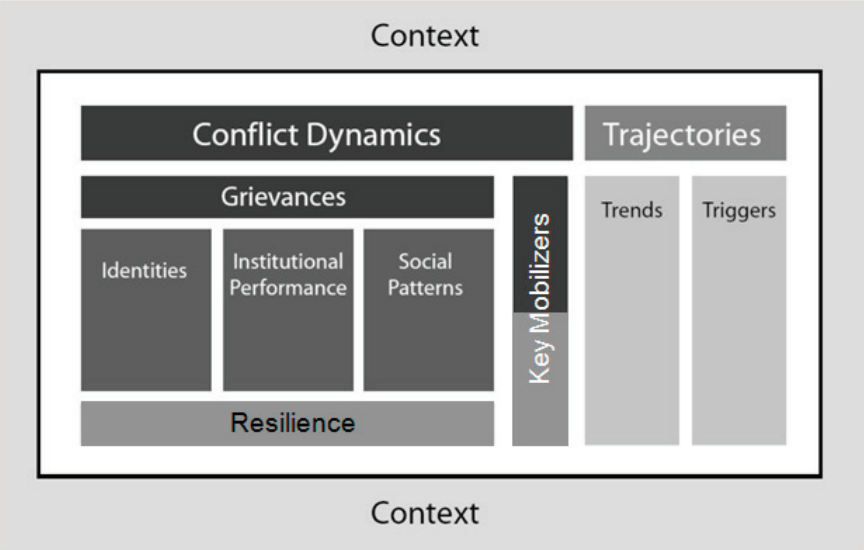

FIGURE 2-2 USAID's Conflict Analysis Framework 2.0. The framework is used to identify current conflict dynamics, possible future trajectories, and potential options for response to the crisis. SOURCE: USAID, Reiling workshop presentation.

USAID began conducting conflict vulnerability analyses around 2000 and published its first Conflict Assessment Framework (CAF) in 2004 and revised it in 2012. CAF 2.0 (Figure 2-2) now connects analysis more closely to response so that development activities have greater impact.[3]

USAID developed the framework to integrate conflict assessment more closely with programming, Reiling explained. Monitoring of the program can guide subsequent analyses, resulting in a continuous learning process. Systems thinking has the potential to improve the quality of analysis and design and to help with operational planning and processes in development more generally.

CAF is based on a theory of how and why armed conflict occurs. All societies have conflicts, including latent conflicts that are not necessarily violent. Conflicts are not only inevitable but often desirable—they spur competition for innovation and help people achieve their goals. But when conflict becomes violent, the consequences can be devastating from development and

[3] CAF 2.0 is available on the USAID website, at www.usaid.gov/what-we-do/working-crises-and-conflict/technical-publications.

humanitarian perspectives. Conflicts therefore need to be managed so that they do not become violent.

Reiling then described a series of features of CAF that can be used to analyze and understand conflict in order to identify, support, and design conflict management institutions and programs. First, the framework takes account of the intersection between identity, institutions, and societal patterns, and the grievances, resiliencies, dividers, and connectors in a society.

Identity involves how people see themselves and how others see them. It can be based on nationality, ethnicity, religion, gender, social class, and/or occupation. Many or all of these features of identity may be present in a single individual.

Institutional Performance involves the laws that help people resolve differences effectively and legitimately. Courts are a common form of conflict resolution in most societies. Their institutional performance can be gauged by whether they work, whether they are legitimate, and whether people perceive them to be fair.

Societal Patterns emerge from the interactions of identities and institutions over time. For example, a social identity that affects legal decisions in a way that creates a persistent sense of exclusion or inequality can lead to a profound grievance. When adequate rules are in place and generally applied consistently, grievances do not necessarily lead to violence because the established institutions manage the conflict.

In addition to social factors, key mobilizers are needed, said Reiling. Conflict requires leadership, organization, financial and human resources, and weapons, all of which call for individuals and groups who have the means, the motivation, and the resources to provide these necessary ingredients.

Peacebuilding also requires key mobilizers—people and organizations that can work with the system to prevent or eliminate conflict. In cases of legitimate grievance, these people and organizations may assist groups or individuals in seeking redress through nonviolent measures. Peacebuilders may need to distinguish between groups' or individuals' interest in violence to redress a grievance and their pursuit of violence to achieve private gains or maintain the status quo.

Reiling described three features of the framework designed to accommodate changes as a conflict evolves over time: context, trends, and triggers.

Context, which often changes slowly, might include geography, environment, or external relations. For example, minerals such as diamonds are part of the environment and, if present in a country, their economic value and related concerns may influence decisions by governments, peacebuilders, development officials, or armed or criminal groups.

Trends, such as increasing urbanization, growing crime, climate change, or environmental degradation, could be or become a major driver or mitigator of conflict. For example, a trend in exclusion from a resource (i.e., broader or narrower) can affect people's calculations of their costs and benefits in deciding whether to engage in violence.

Obvious ***triggers*** of conflict may be a disputed election, an assassination, or an armed attack, but triggers can also be unpredictable or the work of a lone individual, such as a man setting himself on fire as a protest against police abuse, an act that sparked the recent revolution in Tunisia.

These elements intersect and therefore can be depicted as a systems map. Although mapping has been used occasionally in conflict assessments, Reiling said the challenge is to produce a map that is at once comprehensive enough to be illuminating and straightforward enough to inform decision making.

Last, Reiling described three possible approaches to conflict assessment that can be used with or without a systems engineering lens (they are summarized in chapter 4 of CAF 2.0).

Design peacebuilding programming based on a theory of change. A theory of change defines how a group expects to reach a commonly held long-term goal. Analysis of the conflict determines the steps necessary to create peace and shows how each step enables the next. For example, a program to improve community relations with the police following the collapse of an authoritarian state could begin with basic training for the police to explain how they should behave, continue with mediated meetings between the police and the citizenry to set expectations as to police behavior, and conclude with a series of surveys to track improvement. Each step would be decomposed into a series of related activities. Reiling suggested that the theory of change lends itself to an engineering solution because it requires stakeholders to carefully define what activities in what sequence will produce the desired outcome.

Build conflict sensitivity into traditional development programming. Most USAID programs are focused on achieving a development objective

such as improving education, strengthening the rule of law, supporting the court system, or getting people employed. They may or may not be attempting to mitigate conflict through this work, but in many countries affected by or recovering from war, it will be impossible to ignore the dynamics of the conflict as they affect (and are affected by) a particular project. Development programs need to be sensitive to conflict so that they make a situation better rather than worse. As with the first approach, this requires an understanding of the dynamics of a conflict through conflict analysis.

Enhance institutional resilience to conflict. One way to sustainably build peace is to work with a country's own systems for managing and resolving disputes; these might include politics, the security sector, justice and rule of law, employment and service delivery, and overall administration of the state. By identifying actors who are trying to bring people together, contextual factors that encourage peace and social inclusion and the indigenous capacities that foster peace, the framework can be used to support programming that reinforces these positive elements in a society.

MANAGING CONFLICT

Sharon Morris discussed Mercy Corps and its work as an international relief and development organization focused on high-risk transitional environments in both conflict and postconflict settings. These are very challenging but also environments of opportunity.

The organization's approach to managing conflict intersects traditional peacebuilding and development. Most of its programs start by convening different groups, as in traditional peacebuilding. For example, a program in Somalia convenes people from across a wide range of social fault lines—clan elders, business leaders, youth, women, government officials, and representatives of the private sector—and works with them to provide the tools and skills they need in negotiation, conflict management, and conflict analysis to talk about the difficult issues that lead to violence.

However, the program also recognizes that simply bringing people together is usually not enough. Most conflicts have deep underlying causes related to development, and unless development is combined with peacebuilding, a recurring cycle of violence is likely. In Somalia, competition over access to natural resources is deep and long-standing. In the timber areas where Mercy Corps works, conflict centers on the charcoal trade and is getting worse because of the impacts of climate change and drought. It is a very difficult problem, because a ban on charcoal production in an area where the

natural resource base was severely eroding put young people and women out of work, requiring development assistance to provide alternative employment. Thus, Mercy Corps's work sought specifically to negotiate agreements related to tensions over the charcoal trade.

Mercy Corps is using this model in more than 30 programs around the world and is achieving "very positive results," according to Morris. In Ethiopia, for instance, a program that blends peacebuilding with natural resource management led to a reduction in violent incidents, an increase in freedom of movement, and an increase in well-being among the communities versus comparison groups that did not receive the intervention. Furthermore, the communities that received the intervention had an increased resilience to drought, because, with access to markets, they were able to share scarce resources more effectively. These positive changes created a virtuous cycle to replace the vicious cycle caused by dwindling natural resources.

One of the central challenges of peacebuilding is that it takes place in a conflict environment rather than a stable environment, whereas many development programs are designed for stable environments. "If you [put] a youth employment program . . . in a place like the Niger Delta, it's not going to work," said Morris. In the Niger Delta, profound market distortions have arisen from endemic violence among communities that has eroded the trust necessary for a functioning market. Furthermore, the relationship between the private sector and youth is deeply damaged. For example, rather than turning to the private sector for employment, some young people see it primarily as a target for kidnapping, extortion, and other sorts of criminal activities. Interventions need to take account of such distortions to work.

As another example, Morris discussed a large youth program that Mercy Corps operates in Kenya, designed to deal with violence in the lead-up to the elections in March 2013. It is a complex program, with components for economic development, civic engagement, and youth leadership.

Research has shown that young Kenyans participate in violence for a number of reasons, said Morris, such as a lack of dignity, a lack of respect, or a feeling that a community is being disadvantaged in some way. In a stable setting, a youth program would be uncontroversial, but in Kenya, where youth are seen by many politicians as a political weapon to threaten and intimidate opponents, the program has become highly politicized. Politicians on all sides are protesting the program, which reaches a million youth, because it reduces their ability to direct the young through money, ethnic affiliation, or appeals to young people's need to belong. The program is designed to give young people the skills needed to deal with the perverse

dynamics of their situation. Approaches include creating a support system for young people, pairing them with adult mentors, and building coalitions of moderate adults. Another important component in this program has been creating the capacity to communicate with youth—an SMS[4]-based system that provides warning to enrolled youth that political elites may try to manipulate them and encourage them not to participate in any emerging protest and associated violence. The goal is not to support any particular political movement but to break the linkages that enable political elites to use young men to incite violence.

In Iraq, a Mercy Corps program has created a network of more than 100 Iraqi leaders crossing all fault lines—Arabs and Kurds, Sunni and Shi'a, men and women, government and tribal elders, and civil society leaders. The group includes both "good guys and bad guys," according to Morris, because "if you are not pulling in people who think violence is an okay way to achieve their objectives, you are not doing your work." This network of leaders has resolved more than 200 disputes to date, some of them major differences between parliamentary factions and between the Sadr militia and the central government.

Because the network often finds out about disputes after they have already escalated, it has been developing an early warning system in which developing disputes can be put on maps and become a focus of attention. "If a tribal dispute over land is flaring up in this province, how can we get the tribal leaders . . . up there fast?" To protect its neutrality, the early warning system is independent of the security forces or government, so the network is seen as belonging to every institution, not just to one.

Mercy Corps would like to increase the level of technological sophistication it can bring to its programs. However, many technologies, including the Internet, are not available in some places where Mercy Corps works, and in other places cell phone technologies are more effective than Internet-based technologies. Also, a given technology may not work in unstable environments, even if many people like to use it. The goal of technology must be to get the right message to the right people. An e-mail or text blast to a million youth may be less effective than getting a targeted message to youth in a particular area saying that a protest is taking shape and asking them what they can do to prevent it.

Morris concluded by observing that peacebuilding projects in the field tend to operate in environments with extremely poor technical support.

[4]Short message service.

Therefore, as a rule of thumb, any tools or systems developed for field deployment need to be very simple. "I have seen some very complex systems being developed, and they are not going to work. Our field team in Iraq is all Iraqi, they are living under deep violence every day, and asking them to take on a whole new complicated system isn't going to work. So the simpler we can keep these tools and approaches, the better." In such low-capacity environments, the challenge is to make the knowledge (e.g., points of leverage, metrics, and data gaps) developed using systems analysis easily available whether through simple tools, well-designed programs, or an effective and coherent strategy.

DISCUSSION

Workshop participants discussed the role of information technology in peacebuilding, the potential applications of technologies in systems approaches, and the multiple roles of peacebuilders. In response to a question about the kinds of information technology Mercy Corps uses in its programs, Morris said the organization uses various different kinds, but as a general rule tries to adopt the simplest, most easily accessible technologies it can. For example, for early warning and crisis mapping applications, Mercy Corps personnel collect information using Excel spreadsheets and integrate and distribute it using Google Maps. In locations where the Internet is unavailable, the NGO relies more on SMS and other cell-phone-based technologies. Like many NGOs, Mercy Corps is not trying to develop technical competence other than that necessary to further the goals of their programs.

Linton Wells, National Defense University, pointed out that some individuals in the peacebuilding community, such as crisis mappers, have considerable technological capacity that is dependent on Internet access. Morris responded that the challenge for such individuals is to make their technology usable in unstable, infrastructure-poor environments. "You have to know enough about the dynamics [of a place] to adapt it and tweak it and make it fit." Otherwise, advocates of technology can try to do too much.

Robert Ricigliano raised the distinction between negative peace, which amounts to the absence of violence, and positive peace, which is associated with the goals Cole described. Far more people around the world are dying of malnutrition and disease than of armed violence, he observed, although violence can lead to malnutrition and disease. Cole pointed out that NGOs typically divide their activities among humanitarian assistance, development programs, and peacebuilding. But an important question is how to marry

these activities to create more resilient communities. "There are overlaps, and we need to bring our strands of programming together." Morris agreed, pointing out that, in Africa, the combination of peacebuilding and development provides communities with the ability to withstand shocks more effectively. One problem for systems approaches is that combining the different activities causes models to become more complex, and thus, perhaps, less useful in the field.

3

The Potential of Operational Systems Engineering

Following presentations describing the major features of peacebuilding, two presenters provided examples of the insight that operational systems engineering can offer peacebuilding. Bill Rouse, Alexander Crombie Humphreys Chair in Economics of Engineering at Stevens Institute of Technology, provided an overview of systems thinking and methods built around a multilevel approach to systems modeling. As a starting point for identifying potential applications to peacebuilding, he discussed a computational model of health care delivery that has been used to conduct experiments supporting decision making in health delivery. Robert Ricigliano, director of the Institute of World Affairs at the University of Wisconsin–Milwaukee, demonstrated a relational model of social processes in South Sudan that has been used to identify leverage points where investment or innovation could have high impact. The two presentations set the stage for the subsequent examination of specific cases, described in Chapters 4 through 6.

QUANTITATIVE SYSTEMS ANALYSES

Systems thinking is not new or restricted to engineering, Rouse said. People have used it for more than a century, starting with the scientific management of Frederick Taylor in the late 1800s. Rouse defined systems thinking as "the process of understanding how things influence one another within a whole, and an approach to problem solving that views problems as parts of an over-

all system." Thus, the interdisciplinary field of systems engineering focuses on how complex undertakings should be designed, developed, and managed over their life cycle. Moreover, systems approaches emphasize causality and design in a holistic perspective and attempt to avoid the arbitrary boundaries that people often create to overcome complexity in conceptualizing an integrated whole. Initially, systems approaches were used to describe physical systems. More recently, however, systems engineering has been applied to complex systems in biology, medicine, and education. These complex, human-centered systems have traditionally been the province of the social sciences and so were not, in a classic sense, "engineered." Still, like physical systems, they can be modeled.

To understand such complex systems, a widely used approach is to model the interactions between (1) individual workers' activities, (2) work processes, (3) organizations, and (4) society. Using Table 3-1, Rouse described the issues that can be understood at each layer in such a model and gave examples of systems modeling approaches or tools that could be used to analyze these issues. For example, techniques to model the macro supply

TABLE 3-1 Social Systems Can Be Conceptualized as Hierarchical Networks with Multiple Levels, Issues, and Approaches

Level	Issues	Modeling Approaches
Society	GDP, Supply/Demand, Policy	Macroeconomic
	Economic Cycles	System Dynamics
	Intra-Firm Relations, Competition	Network Models
Organizations	Profit Maximization	Microeconomic
	Competition	Game Theory
	Investment	Discounted Cash Flow, Options
Processes	People, Material Flow	Discrete-Event Models
	Process Efficiency	Learning Models
	Workflow	Network Models
People	Consumer Behavior	Agent-Based Models
	Risk Aversion	Utility Models
	Perception Progression	Markov, Bayes Models

SOURCE: Rouse workshop presentation.

and demand characteristics of society as a whole include macroeconomics, system dynamics, and various network models. At the next level down, game theory and option theory can be use to understand how organizations generate competitive advantage, profit, and returns on investment. Organizations can be decomposed into networks of individual work processes that can be described using event models and again network models. Finally, at the lowest level, the behavior of people can be modeled using agent-based models or utility models to capture the incentives that govern the activities of individual workers.

Implicit in this table is a major question that must be addressed as the model is being developed. What is the appropriate level of aggregation? In modeling peacebuilding, for example, should each person be simulated, or each group? The answer depends very much on what issue the analyst wishes to address. Comparable questions apply at each level of the system, from individuals to the domain ecosystem. In addition, models can focus on different aspects of a system, from economic cycles or policies at the societal level to consumer behaviors and risk aversion at the individual level, with different approaches answering different questions but having very different data needs. Rouse emphasized that, for a given problem, multiple models based on different modeling approaches may be an effective way to explore different aspects of the problem, as opposed to developing a single model that addresses all questions and information needs.

Rouse demonstrated the power of this approach with a model evaluating the Emory University Prevention and Wellness Program to prevent diabetes and heart disease. The model operates on the same four levels shown in Table 3-1. Society provides a set of rules, policies, incentives, and cultural structures that defines the context within which Emory University's hospital operates. The hospital houses many different business processes, including the Prevention and Wellness Program, each of which may affect the other. Interactions between individual clinicians and patients occurs at the lowest level. As illustrated in the account in Box 3-1, the advantage of this approach is that "what if" experiments can be conducted on computers, without incurring the expense and real risk of actually implementing changes and then measuring their effects. Such models are especially useful for planning policy and evaluating options.

The point of such exercises is to generate insight rather than make predictions. Similarly, in peacebuilding, a probability of conflict is not a very useful number, but a compilation of all the things that could go wrong, along with a list of the factors that could contribute to their emergence, could be

Box 3-1
Emory University Predictive Health Institute
Prevention and Wellness Program Simulation

Emory University and its Predictive Health Institute (PHI) modeled a prevention and wellness program that would prevent diabetes and heart disease, including the development of a Simulation Dashboard to simulate alternate outcomes. The program was evaluated with 700 employees to explore whether it should be extended to all 20,000 employees.

Almost immediately, the simulation revealed that the system was not sustainable because of increasing costs. To address this problem, the project brought together all of the stakeholders for a formal design exercise in which they could suggest a change and test it using the dashboard. Stakeholders could vary their assumptions about the future, the data they were using, the number of people hired and terminated, the retirement age, and other factors to probe the effects of changes. Unlike a peacebuilding intervention, in which success can not easily be reduced to a single metric, the model used return on investment (ROI) as the principal measure for testing different health care strategies.

The project demonstrated that investments in health and wellness for employees could produce a 7 percent ROI. However, this rate of return did not come from scaling up Emory's current prevention and wellness program, which would produce a substantial negative rate of return. Instead, the positive rate of return came about by focusing on the approximately 10 percent of people who were at highest risk. Based on these results, Emory has moved to reorganize its health care delivery system.

The modeling for Emory extended only through age 65, but when extended to age 80 the ROI rose from 7 percent to 30 percent. On a purely economic basis, it does not make sense for Emory to invest in the health of its employees in such a way that they will be healthier after they retire, but it would be of great benefit to Medicare. By incentivizing employers to produce healthier employees, the Center for Medicare and Medicaid Services (CMS) could substantially reduce the costs of Medicare, Rouse pointed out, but today the two systems are separate and would require a dialogue to link those interests.

very useful in improving intervention strategies for peacebuilding. Leading indicators that are predictive of events could also be identified, though human judgment is essential in selecting such indicators.

Simulations also can be used to explore potential mitigations. Again, the product would be insights rather than predictions, but they could be translated into well-founded instructions for people on the ground to pay attention to critical factors and to avoid actions that could exacerbate conflict. Simulations could help answer questions such as the following:

What can go wrong?
How likely are these scenarios?
What factors might contribute to their emergence?
What are leading indicators of these factors being in play?
How effective are potential mitigations of these factors?

In the development and use of systems models, Rouse stressed the importance of engaging stakeholders so that they understand what is happening in the model, rather than thinking of it as a black box that produces numbers. With understanding, stakeholders start to take ownership of the results. In that sense, as General Eisenhower observed, planning is far more important than the plans themselves. People begin to understand interdependencies rather than assuming that factors are independent, and, in a multi-stakeholder conversation, they begin to understand the perspectives of other stakeholders, which can be as important as the results.

QUALITATIVE SYSTEMS ANALYSES

In contrast to the computational model described by Rouse, Robert Ricigliano demonstrated a relational model that probes the interactions among components of a system. It, too, produces insights that can be used to aim, implement, or redirect policies more effectively, rather than yielding specific predictions.

Part of the Joint Irregular Warfare Analytic Baseline (JIWAB), the model was produced to explore ways of using systems maps to improve joint interagency planning. The goal was not to actually produce a plan for intervention but instead to evaluate how systems methods could be used in the interagency planning process. The systems map shown in Figure 3-1 and used in the JIWAB sessions broadly describes how security, government capacity, and development issues affect the legitimacy and credibility of the Government

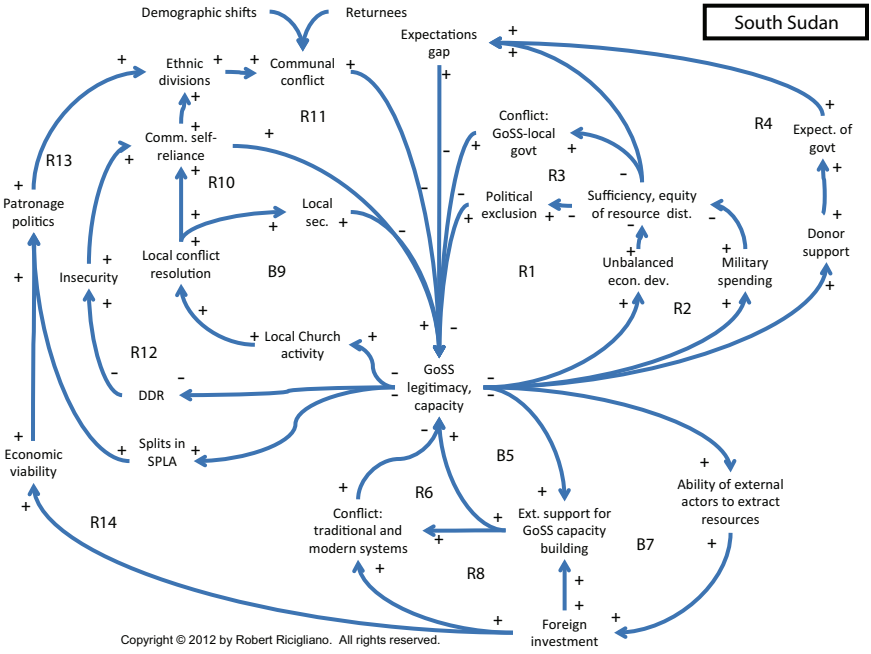

FIGURE 3-1 A systems analysis of South Sudan centers on the legitimacy and capacity of the Government of South Sudan (GoSS). Each arc describes how change in a node at the tail of the arc will affect the node at the arrow head. Plus signs indicate increases and minus signs indicate decreases. For example, the arc joining GoSS legitimacy and capacity to unbalance economic development in R1 should be read, "Decreases in GoSS legitimacy and capacity tend to increase imbalance in economic development." SOURCE: Ricigliano workshop presentation.
Note: DDR is Disarmament, Demobilization, and Reintegration; SPLA is the Sudan People's Liberation Army.

of South Sudan. Ricigliano emphasized, however, that the data-gathering process that produced this map lacked the resources (time, quantitative data, and personnel) necessary to produce a reliable policy tool. Despite that, the map was sufficient to test how systems might be used in interagency planning processes, and he thought it would be sufficient to enhance the potential of systems in planning multi-stakeholder interventions for peacebuilding.

At the JIWAB workshop, planning teams from the Department of Defense, the State Department, and the US Agency of International Development (USAID) were given the systems map and asked to describe what

their organization would do in South Sudan to improve the legitimacy and credibility of the government. Working separately, each group discussed a different portion of the system based on their own mission. Initially, Defense focused on security sector reform; State on enhancing government capability; and USAID on economic development and donor relations. With time, however, the three teams independently focused on the same portion of the map. To understand why, Ricigliano first described in some depth the construction of the map.

A systems map is not just a prettier way to show relationships, said Ricigliano. It is a visualization technique for building a richer, shared narrative that leads to more effective peacebuilding. The systems analysis shown in Figure 3-1 evaluates what factors were affecting the legitimacy and capacity of the Government of South Sudan (GoSS)—from the perspective of the interagency teams, the primary reason for intervening. Fourteen unique loops start and end with the central variable, "GoSS legitimacy, capacity." These loops are divided into 11 marked *R* for reinforcing and 3 marked *B* for balancing. Ricigliano explained that positive feedback that strengthens each variable in the loop characterizes a reinforcing loop. For example, around loop R1, lower government legitimacy causes greater imbalance in economic development. These increasing imbalances lead to greater inequity in resource allocations within South Sudan, which causes greater political exclusion and further undermines the government's legitimacy. A reinforcing loop creates a cycle of change which, depending on one's perspective, can be good—a virtuous cycle—or bad—a vicious cycle. A balancing loop, on the other hand, contains negative feedback that resists change and stabilizes each variable within the loop. For example, in B6 a decline in government legitimacy encourages external donors to invest in capacity-building projects that improve government legitimacy.

Analysis of these loops can reveal multiple feedback mechanisms that may produce unexpected results—positive, negative, or both. In JIWAB workshop, Ricigliano continued, although each group initially focused on their area of competence, after about forty-five minutes of discussion, all three groups were focusing on the portion of the systems map shown in Figure 3-2. Compared to the rest of the map, this subsystem interested the three teams because it contained two of three balancing loops in the system and because it related foreign investment (both public and private) to changes in government legitimacy. Most interestingly, this subsystem linked foreign investment to the potential for increased local conflict between traditional and modern systems.

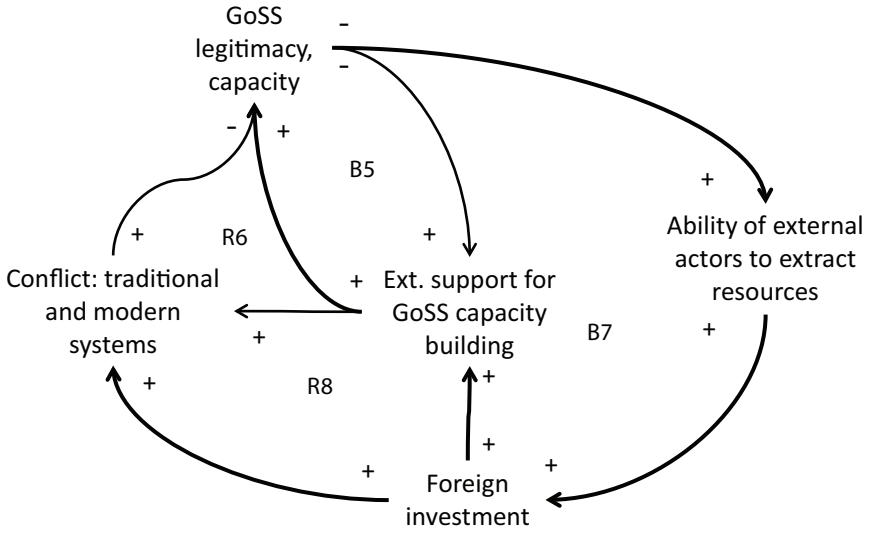

FIGURE 3-2 A subsystem shows how external support for Government of South Sudan (GoSS) capacity building and foreign investment can both foster government legitimacy and exacerbate conflict between the traditional and modern elements in South Sudanese society. SOURCE: Ricigliano workshop presentation.

Looking a little more closely at Figure 3-2, Ricigliano pointed to loops B5 and R6 as central to the question of how external agencies should make investments. Loop B5 shows how decreases in the legitimacy and capacity of the government of South Sudan tend to result in increased external support from international organizations. This support rebuilds the government's capacity by funding new programs to deliver services to the citizenry. At the same time, however, loop R6 shows how external support may also increase conflict between traditional and modern systems. If newly funded government agents now have the vehicles and gasoline to go to rural villages and say, "We are here to tell you how to do things," the tribal chiefs and other traditional forces are likely to say, "Why do you think you can tell us anything?" Such conflict—over who has authority over such basic governing activities as the judiciary, security, and business—can further undermine the legitimacy of the government, leading to a reinforcing cycle of increased external investment and heightened conflict between the modern state and traditional local authorities. Loops B7 and R8 describe the same effect for private investment.

If the reinforcing loops (R6 and R8) are stronger than the balancing loops (B5 and B7) shown in Figure 3-2, as the experts in the JIWAB work-

shop judged them to be, external support and foreign investment will likely increase conflict between the traditional and modern elements of South Sudanese society. For that reason, the planners at the meeting eventually all focused on the conflict between traditional and modern systems, determining that conflict could be avoided if the two systems could work together, Ricigliano said. Each of the three groups in the JIWAB workshop was able to make some contribution in its own domain to reducing the conflict between traditional and modern systems. Thus, this location on the systems map is a leverage point where investments or innovation could have high impact. If multiple efforts could be brought to bear here, positive changes would reinforce each other and be amplified rather than undermined by the system.

This is a powerful way in which systems analysis can guide investments, said Ricigliano. A systems map can demonstrate the existence and location of an engine for change that can affect the entire system. Analysis produces a theory of change about implementing programs and about how those programs could affect the system as a whole.

DISCUSSION

The construction and use of systems maps can be complicated, as Ricigliano observed in the discussion session. In many cases, it is not immediately clear whether the signs at the start and end of an arc joining two nodes in a system map should be positive, indicating an increase, or negative, indicating a decrease, in the value of the node. Constructing and modifying maps therefore requires ongoing data collection and analysis. Ricigliano thought that, although the peacebuilding community is more comfortable with gathering data than it has been in the past, it still is not at the level of, say, the health care community.

Outcome data need to be incorporated into both initial formulations of the analysis and subsequent modifications of the systems map. If an intervention backfires, a positive sign on a map may turn to a negative sign. In general, when reality differs from the model predictions, modelers have an opportunity to learn why things turned out differently than expected. The slogan Ricigliano uses is "fail smart, learn, and adapt fast." But he said the peacebuilding community is not currently set up to fail smart; it tends to bury mistakes, rather than learning from them by validating or invalidating testable hypotheses to improve understanding over time based on *both* failure and success.

Maps also need to be contextualized, which means they will be different for different places, as Ricigliano noted in response to a question from Alfred Blumstein, Carnegie Mellon University. But dynamic systems will have patterns that, although varying based on context, will be replicated from place to place. The instability caused by foreign investments in local communities shown in Figure 3-2 is likely one such pattern of behavior. Once these patterns are recognized, learning from conflict to conflict by incorporating previous experience and knowledge becomes possible. By identifying such patterns using systems maps, learning can become more institutionalized.

Ricigliano acknowledged, in response to a question from Hrach Gregorian, Institute of World Affairs, that, as in other endeavors, the quality of the data used to build or modify a map affects the quality of the output. It is therefore important to have multidisciplinary teams working on a map to bring different kinds of data to the process of building and testing it.

Much of the value of a map derives from the interactions that occur in building it. These interactions result in a collective understanding and sense making that can be captured in the relationships of a map. In the exercises in which Ricigliano has been involved, representatives of the Defense Department learned the perspectives of the State Department, USAID, the Justice Department, NGOs, and/or academic representatives. These interactions also help shift the emphasis from a linear problem-solution frame, to a systems frame that is both process based and iterative. When this happens, participants know that they are working with a system and not just a checklist.

Rouse also reiterated the importance of the process of building a model, again evoking Eisenhower's statement that plans are useless but planning is indispensable. A systems approach requires bringing together people with very different backgrounds and expertise to talk with each other, often for the first time. "Getting the different stakeholders to understand [each other's] concerns and issues is a big step."

Steven Robinson, University of Wisconsin–Madison, observed that a range of outcomes with probabilities attached to each is often more useful than a single outcome. For example, if a policy has a 60 percent chance of good outcomes but a 40 percent possibility of disaster, a policy with a 20 percent chance of good outcomes (and a significantly lower risk of disaster) may be a better choice. Simulations can be run multiple times with changes in assumptions to generate a range of outcomes.

Rouse pointed out that models can also reveal which missing data elements make the most difference. Thus they can be used to screen the sensi-

tivity of factors, identify which should be the highest priority for research, and direct data collection.

As Ricigliano observed, a systems mapping approach can indicate the *where* and the *what*, but it does not help much with the *how*, which requires the use of quantitative tools. Such tools are needed to implement programs effectively. A decision about *where* to intervene might be best answered by understanding the problem as a system complete with powerful feedback loops that can produce unpredictable second-order effects. On other hand, once the *where* has been determined, the question of *how* to intervene is often a fairly straightforward activity that defines goals, programming, and methods to monitor and evaluate impact.

Finally, Ricigliano noted that a map is not a quantitative model. The evolution from a map to a quantitative model, to produce the tools described by Rouse, forms a major part of the operational systems engineering discipline. Peacebuilding can benefit from qualitative applications such as systems mapping, but greater, substantial benefits can be anticipated as quantitative methods and tools are brought to bear.

4

Case Study: Election Violence in Kenya

In the afternoon, the workshop broke up into three parallel breakout discussions to look at specific issues in Kenya, South Sudan, and Haiti and at what methods might allow the application of systems engineering in each case. Drawing on materials prepared before the workshop and on brief plenary presentations on the three cases, subsets of workshop participants discussed each situation in depth, prepared analyses, and proposed actions that were presented in the final plenary session of the workshop.

This chapter describes the deliberations and conclusions of the subgroup that examined election violence in Kenya. Chapter 5 examines food security in South Sudan, and Chapter 6 looks at post-earthquake peacebuilding in Haiti.

A HISTORY OF ELECTION VIOLENCE[1]

From 1964 to 1991, Kenya was a de facto one-party state, after the Kenya African Democratic Union (KADU) merged with the Kenya African National Union (KANU), led by President Jomo Kenyatta (a member of the Kikuyu ethnic group). In 1991, Kenya's second president, Daniel arap Moi (a mem-

[1] The introduction to this chapter is drawn from a background paper prepared for the workshop by Ryan Shelby, Christine Mirzayan Science & Technology Policy Fellow and J. Herbert Hollomon Fellow at the National Academy of Engineering.

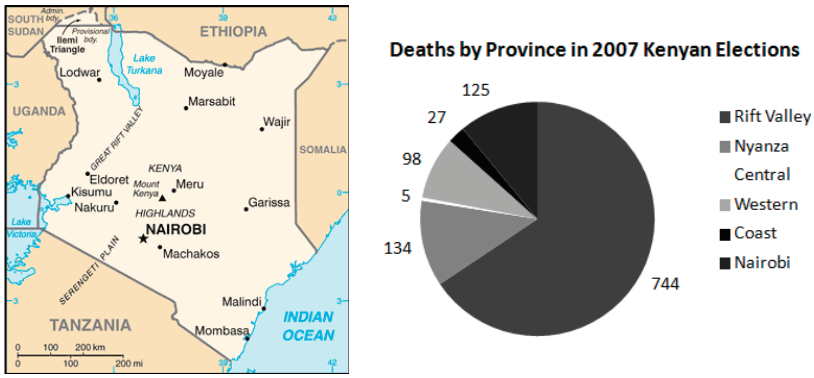

FIGURE 4-1 The Rift Valley province, stretching from the northern border to the southern border in the western part of Kenya, was the main site of organized violence associated in the 2007 elections. SOURCE: CIA World Factbook, "Final Report," Commission of Inquiry into the Post Election Violence (CIPEV), 2008.

ber of the Kalenjin ethnic group), introduced the first multiparty election system since Kenya's independence in 1963. In the lead-up to the first such elections in 1992, groups and individuals affiliated with the KANU organized gangs of armed young men, with the promise of land and jobs, to carry out violence against members of the Luo, Luhya, Kamba, and Kikuyu ethnic groups in the Rift Valley (Figure 4-1). This resulted in approximately 250,000 people displaced (mainly Kikuyu) and approximately 1,500 people killed (Figures 4-2 and 4-3).

In 1997 multiparty elections were again marred by organized violence against groups in the Rift Valley and Coast provinces that were viewed as opposed to the KANU. Approximately 100,000 people were displaced and about 400 killed.

The 2002 election featured two Kikuyu contenders for the presidency: Mwai Kibaki of the newly formed National Rainbow Coalition (NARC) and Uhuru Kenyatta of the KANU. The 2002 election of President Kibaki is notable for the relative lack of organized violence and was deemed to be fair and free, although there were reported incidents of a small number of deaths (fewer than 200) and evictions.

The aftermath of the discrepancy-laden December 2007 Kenya election resulted in more than 630,000 people displaced and 1,133 killed, most of them in the Rift Valley (Figure 4-1). Pre- and post-election violence included excessive and calculated use of police forces to intimidate Orange Demo-

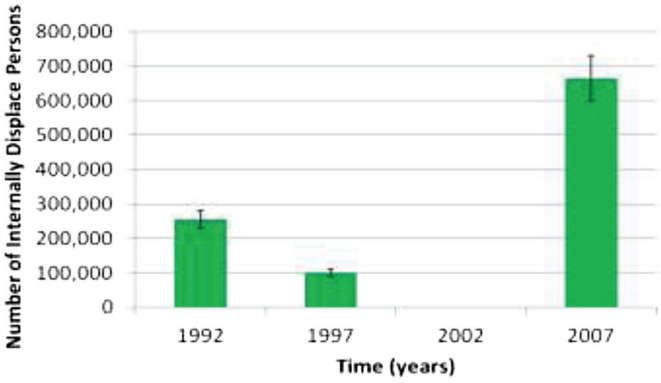

FIGURE 4-2 The number of Internally Displaced Persons (IDPs) rose as a result of election violence in 2007 after declines in previous Kenyan elections. SOURCE: "Final Report," Commission of Inquiry into the Post Election Violence (CIPEV), 2008.

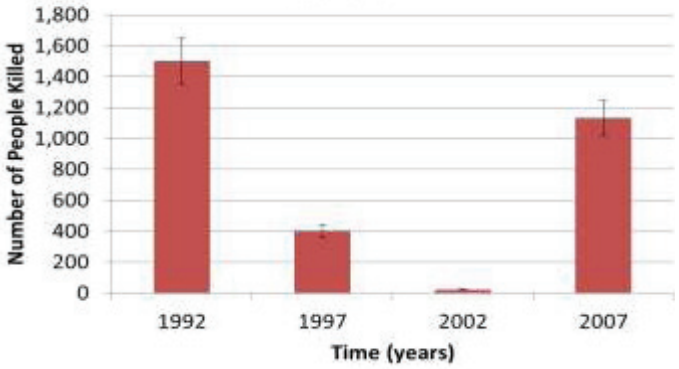

FIGURE 4-3 Deaths associated with the 2007 election in Kenya rose after declines in the previous two elections. SOURCE: "Final Report," Commission of Inquiry into the Post Election Violence (CIPEV), 2008.

cratic Movement (ODM) members, the rape of women by police forces, use of live ammunition against demonstrators, attacks by armed youth militias such as the Mungiki against ODM supporters, and attacks by ODM-affiliated groups such as the Sabaot Land Defense Force against supporters of President Kibaki's Party of National Unity.

SUPPORTING NONVIOLENT ELECTIONS

Dorina Bekoe, research staff member in the Africa Program at the Institute for Defense Analyses, reviewed the major peacebuilding challenges in Kenya. At the time of the workshop, tensions were building in anticipation of an election scheduled for March 4, 2013. For example, the Communications Commission of Kenya established regulations for the content and distribution of political messages. First, they could not contain hate speech, which had been a critical factor in fostering electoral violence in 2007. Second, the messaging had to be in English or Swahili, the two most commonly understood tongues, to ensure transparency. Third, it had to be cleared in advance by the Commission to prevent nonstandard media channels from being used to incite violence as community radio had been used to do in 2007. And finally, political messages had to be issued between 6:00 AM and 6:00 PM.

Other pre-election activities included work done by the Electoral Institute for Sustainable Democracy in Africa, which put together conflict management panels in Kenya and conducted training and workshops to forestall possible violence. An elections observation group established in 2010 before a constitutional referendum in Kenya planned to monitor the election and check the vote tabulation, which was a problem in 2007, because the electoral commission was perceived as biased. US-based organizations were also working with other domestic groups on planning and training.

One of the most significant pre-election episodes of violence occurred in August 2012 in the Tana Delta, according to Bekoe. It took the form of communal clashes between the Orma, who are largely Muslim and pastoralists, and the Pokomo, who are Christian and agriculturalists. The violence, which resulted in more than 100 dead and about 12,000 displaced, ostensibly centered on access to the delta for cattle or crops. But behind the scenes, politicians were maneuvering to be elected and establish coalitions, raising the potential for political conflict.

Other hotspots included the Rift Valley and the Eastern provinces, where ethnic tensions were combining with political machinations to increase the likelihood of violence. Politicians play on preexisting ethnic grievances, many of them involving land use, to recruit voters, said Bekoe. In addition, politicians who had been found responsible for inciting violence in the past had not been punished, creating a sense of impunity that could contribute to future violence. Furthermore, police reforms were lagging in Kenya.

BREAKOUT GROUP DISCUSSION

According to Jose Emmanuel Ramirez-Marquez, director of the Engineering Management Program in the System Development and Maturity Lab at Stevens Institute of Technology, who reported on the breakout group discussion, a major challenge in applying operational systems engineering to peacebuilding in Kenya is identifying the data needed to enable more peaceful elections. Such data would help in the mapping of relationships that promote violence and could thus inform steps toward the stabilization of Kenyan elections.

A related issue is the development of conflict assessments, and particularly the metrics used for them. Conflict assessment is different from systems engineering, which takes a much broader view of the context, not just the conflicts. As Sheldon Himelfarb, director of the USIP Center of Innovation for Science, Technology, and Peacebuilding, noted, NGOs have tended to focus on flashpoints rather than more broadly assessing the structure and dynamics of a conflict.

The breakout group focused on two major objectives, said Ramirez-Marquez. The first was the local capacity for maintaining peace. Local systems can be seen as components of larger systems and analyzed separately, if information and data are available at that level of detail, and thus serve as representative test beds for larger systems analyses. If data are not available for such an analysis, a systems approach can be used to identify the data needed to understand a local situation and establish an agenda for data gathering and research.

The second objective addressed by the group was the development of an early warning and early response system for election-related violence. Such a system would depend critically on the provision of the information and on the actions of those who receive it. Many early warning systems exist in Kenya at local, regional, and national levels, but the relationships between them are not clearly established. If systems analysis indicated that connecting a subset of systems would yield more useful warnings, this could be an important benefit of such an approach. The Kenyan government has an early warning system, and various peacebuilding groups were feeding information into it, but whether any action would be taken based on the warnings was still unclear, said Ramirez-Marquez.

The group decided on three concrete steps that could be taken:

Use a systems approach to map the situation in Kenya in order to form testable hypotheses.

Examine the sources of data for such a map.

Use these data to build a statistical history of election violence in Kenya, which could be useful in analyzing the future potential for violence.

Bekoe noted that data could be gathered in each of the five areas cited by Beth Cole as desirable end states (see Chapter 2): rule of law, safe and secure environment, sustainable economy, stable government, and social well-being. Commissions formed after large-scale violence in the country have done painstaking data gathering and analyses of conflicts. Furthermore, crowdsourcing systems such as Ushahidi are creating independent and accountable sources of information for people working in potentially violent environments. Using such platforms, activists have been able to collect, visualize, and communicate reports of election violence that have been e-mailed and texted from people throughout Kenya.

Violence often depends on context, said Bekoe, and it has occurred both in traditional hotspots and in new locations. Analysis of data on disputes over time viewed from a systems perspective might yield insights into differences in the number and intensity of disputes. More effective application of systems engineering tools for understanding and planning would be possible with the additional data now available.

Members of the breakout group agreed that the application of operational systems engineering to elections in Kenya could affect the March 4, 2013, election. Because of the lack of time available prior to the elections, however, the impact of any analysis undertaken by the working group would most likely be retrospective rather than prospective. Even such retrospective analysis, members thought, could demonstrate the applicability of systems engineering to peacebuilding while enabling learning that would support future applications in places such as presidential elections in Afghanistan in 2014 and parliamentary elections in Burma in 2015.

5

Case Study: Food Security in South Sudan

In January 2011 the South Sudanese people voted overwhelmingly, in a referendum established as part of the 2005 Comprehensive Peace Agreement (CPA), to secede from Sudan and create the world's newest nation (Figure 5-1).[1] South Sudan has about 10 million people in an area about the size of Texas. Despite substantial national income from oil resources, the country's income distribution is highly unequal. Over half the population lives on less than a dollar a day, government services are extremely limited, half the population lacks clean, potable water, and a third lacks access to health care.

Furthermore, histories of ethnic grievance coupled with meddling by political elites at the national and regional levels have caused local disagreements between communities over land use, land ownership, and resources to escalate into violent conflict. Such disputes typically manifest as raids to steal cattle and sometimes to abduct women and children. Although these raids have been portrayed as economic acts driven by young men needing cattle for marriage dowries, recent intertribal conflicts point to communal and political dimensions.

The cumulative effect of raids is a continual stress on farming, but agriculture in South Sudan is rudimentary in any case. Although more than 70

[1] The introduction to this chapter is drawn from a background paper prepared for the workshop by Andrew Robertson, Senior Program Officer, US Institute of Peace.

FIGURE 5-1 South Sudan became the world's newest nation in 2011. SOURCE: CIA World Factbook.

percent of South Sudan's landmass is thought to be arable, and although the Nile and its many tributaries water these lands, only about 4 percent of South Sudan is farmed. Most land either lies fallow or is used to raise cattle—in most parts of the country, tribal culture has traditionally been pastoral rather than agricultural, and wealth and status have been measured by the number of cattle held, not harvest delivered to market. South Sudan's limited agricultural sector is further hampered by primitive technology and high input costs. In 2009 the average value (in US dollars) of production per hectare farmed was $299 in South Sudan compared with $665 in Uganda, $917 in Ethiopia, and $1,405 in Kenya.

Even where agricultural surpluses exist, the absence of an effective national road system limits farmers' ability to serve urban centers of consumption. With the exception of about 300 kilometers of paved roadway linking Juba to Nimule, transport occurs on gravel roadways that are inaccessible during the wet season (from approximately late April to early November). Such urban markets are mostly served by imports from Uganda or Ethiopia.

In addition, high transportation costs limit the adoption of inputs to improve productivity. Agricultural fertilizers and herbicides are almost

unheard of and, because of the cost of transportation, often do not warrant the productivity gains they provide. Replacing self-produced seed varieties with more productive varieties has been impeded by problems of access, training, and capital. Because little economic benefit accrues to early adopters, little incentive exists for investments in technologies to enhance farmer productivity.

Conflict disrupts the already meager food production by destroying scarce farm capital, driving farmers from their land, and disrupting transportation networks. During conflict, farmers are reluctant to invest in their farms. In the least developed nation in Africa, the investment is more basic than machinery. For example, in agricultural communities along migration routes used by pastoralists, fences are a crucial investment for successful farming; without them, cattle from transient tribes will enter fields to graze, greatly reducing yields or even destroying the harvest.

Long-term conflicts also tend to diminish the aggregate skill and knowledge of farming communities. Young men mobilized into militias for extended periods forget agricultural skills necessary to succeed as farmers. Furthermore, without assistance in both buying seeds and equipment and learning how to use them, young men demobilized from militias are unlikely to successfully reintegrate into rural farming communities.

FOOD SECURITY AND PEACEBUILDING

Tim McRae of Food for Peace, USAID, explored the connection between peacebuilding and food security in South Sudan. The United Nations has defined peacebuilding as involving "a range of measures targeted to reduce the risk of lapsing or relapsing into conflict by strengthening national capacities at all levels for conflict management, and laying the foundations for sustainable peace and development."[2] Reducing the risk of conflict and laying the foundations for peace and development require food security, McRae argued. The individuals most likely to participate in armed conflicts are males from rural areas with limited education and limited economic prospects. These are the same individuals who are most likely to work in the agricultural sector to produce food security. If they are not working in agriculture, they are more likely to foment conflict.

[2] See United Nations Rule of Law, section on Peacebuilding, online at http://unrol.org/article.aspx?article_id=27.

According to the United Nations, food security involves food availability, food access, and food utilization,[3] and this definition has been adopted by other international organizations, McRae observed. All three elements must be realized to ensure food security and to create an environment that reduces the possibility of conflict.

Food availability refers to the physical availability of sufficient quantities of food to meet dietary needs for a productive and healthy life. Food may be supplied through domestic production, imports, or food aid. The 2012 crop assessment for South Sudan found that the country faced a cereal deficit of more than 473,000 metric tons.[4] This shortfall was attributed to delayed rains, lack of fertilizers, pests, disease, poor technical capacity, and conflict at the border in addition to fighting internal to the country. Improving food availability in South Sudan requires improving technical capacity, including both production and logistics. Because of the bad road system, the movement of food is extremely limited for a large portion of each year. Building better roads would help reduce the travel time to markets and revitalize trade while providing other benefits, such as improving access to schools and health care facilities.

Food access involves the economic circumstances that allow people to acquire adequate resources for the provision of foods for a nutritious diet. It thus depends on household income, the distribution of resources within a household, and the cost of food. In South Sudan, poverty is a major contributor to food insecurity. Strengthening the agricultural productive capacity of households is essential to moving people from a state of economic deprivation to self-sufficiency, McRae said. Currently, the half of Sudan's population that lives below the poverty line is unable to withstand shocks due to droughts, flood, crop diseases, pests, or theft of livestock, all of which are common in the country. People who are marginally food secure can be reduced to food insecurity by just one of these shocks, as happened when the government shut down the flow of oil in January 2012. Agreements were later signed to release the oil, but inflation and high food prices increased food insecurity. Higher agricultural productivity, improved resilience against various shocks, increased transportation capacity, expanded access to land,

[3] According to the UN Food and Agriculture Organization, "food utilization" is "the way the body makes the most of various nutrients in the food" and is thus related to an individual's nutritional status. Available online at www.fao.org/docrep/013/al936e/al936e00.pdf.

[4] Food and Agriculture Organization and World Food Programme. 2012. *FAO/WFP Crop and Food Security Assessment Mission to South Sudan.* Rome: FAO and WFP.

and better access to credit and to saving mechanisms would all improve food access in South Sudan.

The third component of food security has to do with food utilization, which involves adequate diets, clean water, sanitation, health, and basic principles of nutrition and proper child care. The high rate of poverty in South Sudan limits food utilization, resulting in malnutrition, which has negative impacts not only on personal health but on the growth and development of a country because it stifles productivity for entire economic sectors. More nutritional knowledge, greater access to potable water, and better overall health would help improve food utilization, McRae said.

USAID has been working in the state of Jonglei and other parts of South Sudan to build agricultural capacity, though these efforts have been impeded by continued fighting, especially as many groups have young leaders who are trying to prove themselves, according to McRae. Steps that can be useful include training and employment of local youth, better communications, support of the government's capacity to meet basic needs, development of governance and budgeting skills in the government, knowledge transfer to small-holder farmers, and efforts to promote peace and communication in countries in conflict.

BREAKOUT GROUP DISCUSSION

In asking how systems engineering could be usefully applied to improve food security in South Sudan, this breakout group framed a series of questions that they considered crucial to developing a systems-based solution to the problem:

What are the government's and other stakeholders' objectives?
What is the existing system?
What historical data are available?
Can a rough model be built of the current situation?
Could analogous situations contribute to such a model?
Could existing work inform the development of such a model?

To further organize their thinking, the breakout group adopted the model suggested in the morning session of the workshop by William Rouse (see Chapter 3) as a possible technical approach. At the level of *people*, the group identified calories per day, satisfaction levels, and immediate and long-term needs as important factors. At the level of *processes*, they identified

food production, information processes, education, infrastructure services, security, and conflict management as critical systems components. The *organizations* level included tribes, NGOs, process owners, and political parties. Finally, at the *society* level, government, regulations, and the international community were thought to play a significant role.

The group identified assumptions that seemed to span these four levels: predictability, the need for good metrics, sustainability, ownership of various aspects of the system, stakeholder buy-in for solutions, and cultural values. Among the challenges identified, in addition to those mentioned by earlier speakers, were vested interests, the conflict between immediate and long-term needs, the newness of the government, weak infrastructure, and corruption at various levels. Finally, the group discussed what one would need to know in order to decide between different options for agricultural development such as simple subsistence agriculture, highly centralized farming, or market-focused production.

The group identified expertise and other perspectives that would be needed to provide input into an operational systems engineering model—transportation, agricultural production, logistics, culture, nutrition, public health, the environment, and the dynamics of inter- and intra-tribal politics—and in doing so realized that the outputs of the model would provide compelling information for decision makers.

Finally, the group discussed what kinds of metrics would be appropriate for the model, acknowledging that they can be interdependent and at the same time point in different directions. Among the metrics identified were measures of stability, sustainability, growth of the society, and the access to, availability of, and utilization of food. For example, the percentage of malnourished people, income, food prices, and how quickly food gets to consumers would all be important. Metrics would also need to be used to establish a baseline to enable measurement of the results of implemented changes.

In the subsequent plenary discussion, workshop participants observed that part of the model could be constructed quickly as work progressed on the overall model. They also speculated that observations of ongoing changes in South Sudan could be used to reverse engineer how the system currently works. A dynamic analysis could provide guidance for policy interventions.

The challenge of applying operational systems engineering to peacebuilding is particularly formidable in South Sudan because the country is so new and faces so many challenges. In developing a model to link food security to conflict, the conclusion was that the best approach might be to start simple, determine the most important factors, and gradually add complexity.

6

Case Study: Post-Earthquake Recovery in Haiti

The earthquake that struck Haiti on January 12, 2010, resulted in 222,570 deaths, 300,572 people injured, and approximately 2.3 million people displaced (Figure 6-1).[1] The earthquake damaged or destroyed 60 percent of government buildings and caused major disruptions in communication systems. More than two years later, in August 2012, it was estimated that approximately 369,000 displaced people remained in 541 camps.

In response to the earthquake, concerned global citizens used Web 2.0 technologies to create an online, interactive map that harnessed short message service (SMS) to locate disaster victims, coordinate relief supplies, and guide search-and-rescue teams. The Haiti Crisis Map was built using the Ushahidi platform, an open source mapping system developed during the December 2007 Kenyan elections as a means for laypersons to use SMS and e-mail to record and report post-election violence. The map made use of the collective, local intelligence of Haitian SMS, e-mails, blogs, and Facebook and Twitter posts to continually display and update the status of trapped persons, medical emergencies, food supplies, water, and shelter.

But verification of the validity of these reports or the responses by NGOs and disaster relief workers was limited. This lack of validation points to the

[1] The introduction to this chapter is drawn from a background paper prepared for the workshop by Ryan Shelby, Christine Mirzayan Science & Technology Policy Fellow and J. Herbert Hollomon Fellow at the National Academy of Engineering.

FIGURE 6-1 On January 12, 2010, an earthquake struck near Port-au-Prince in Haiti. SOURCE: CIA World Factbook.

need for a decision support system to rapidly identify inaccurate information, detect early warning signs of conflict or disease outbreak, and maintain the security of information and the privacy of people reporting it.

In October 2010 a lightning-fast and virulent outbreak of cholera swept through the earthquake-ravaged country, killing more than 7,000 Haitians and sickening more than 530,000 despite the presence of the large number of NGOs. In response, the Haitian government established the National Sentinel Site Surveillance (NSSS) system at 51 sites to help decision makers allocate resources and identify effective public health interventions. It also established the Internally Displaced Persons Surveillance System (IDPSS) to facilitate the monitoring of communicable diseases identified in temporary clinics serving displaced people.

It is not known whether the hundreds of NGOs operating in Haiti are integrated into these systems, nor whether there is a common disease surveillance system among the NGOs. Reports indicate that medical responses have been delayed by communication difficulties among NGO partners and by limitations of IDPSS data due to lack of reliable information about the population in camps.

Finally, gender-based violence has been a continuing problem since the earthquake. In a 2011 survey of "households" in four camps near Port-au-Prince, 14 percent of respondents reported that one or more members of their household had been victimized by either rape or unwanted touching or both since the earthquake. More than 10,000 people were sexually assaulted in the six weeks after the earthquake, and over the next three months 24 percent of all arrests by the Haitian National Police involved sexual violence.

There is no systematic collection or management of data on gender-based violence in Haiti, so it is difficult to quantify the occurrence of such violence. Under the dictatorships of François and Jean-Claude Duvalier, gender-based violence was commonly used as a tool of repression. A 2006 report found that approximately 35,000 females and an additional 13,000 *restaveks*, children working as unpaid domestic servants, experienced sexual assault between February 2004 and December 2005.

PERSISTENT CHALLENGES

Robert Perito, director of the USIP Security Sector Governance Center, provided a detailed and vivid view of the situation in Haiti. The tent camps in Port-au-Prince are an example of what he called the "Haiti Syndrome," characterized by chronic disease, poverty, and insecurity exacerbated by a crisis. The January 2010 earthquake not only destroyed 190,000 housing units but was followed by a number of aftershocks that caused people to move out of whatever structures were still standing and into any open space available. Golf courses, public parks, even highway medians filled with tents.

Three years later, more than 500 tent camps remain in the Port-au-Prince area. These camps pose serious hardships for those still living in them, with no electricity, no sewers, no roads, and no amenities, according to Perito. However, he pointed out that before the earthquake some 300,000–400,000 people lived in the slum at the center of Port-au-Prince, Cité Soleil, which the *Economist* at the time described as "having little if any electricity, no sewers, no shops, no form of employment and no police." People came to Cité Soleil from the countryside, and when the agricultural sector in Haiti failed during the 1990s they came in large numbers.

After the earthquake, the international community flooded into Haiti and, among other things, created tent camps that, ironically, were a major improvement in living standards for the residents of Cité Soleil. The camps had new tents, free food, bottled water, and in many cases world-class medical care thanks to the legions of doctors who flew to Haiti. The quality of life

in the camps during the first year was such that it actually encouraged people who lived in or were displaced to the countryside to come live in them.

Residents of the camps who had resources could either rebuild their homes or find new places to rent and move on. Others were resettled to locations far from the city where there are no jobs and few amenities. In many cases, however, people left their names on the camp registers in the hope that they would be resettled in a better house or receive some other benefit. Many of those who remain in the camps are what Perito called "a residual hard-core population" who do not have the resources to rent elsewhere and have not been able to participate in a resettlement program.

A comprehensive government-led effort is needed to resettle the city's homeless, Perito said. But it would require urban planning and resolution of the problem of missing land registration titles. No more than 15 percent of the land in Haiti is registered, and resettlement efforts have been hampered by the fact that nobody knows who owns the land. If someone clears a piece of land, squatters often arrive. If someone builds on a piece of land, people often show up with forged documents claiming they own the land.

The current government program is to clear six areas in the capital city, mostly former parks and open spaces. To provide people with an incentive to leave the camps, the government has been offering to pay their rent for a year. The government also has been sending armed forces to clear the camps. But with few provisions for resettlement, people forced out of camps often just move to other camps.

Further complicating the post-earthquake recovery is the cholera epidemic, which began a year after the earthquake. Cholera was not seen in Haiti until 2011, and it appears to have arrived with a group of UN peacekeeping troops from Nepal, although the United Nations has not admitted responsibility for introducing the disease into the country. Controlling the spread of cholera has been hampered by Haiti's lack of basic infrastructure. Cities have no water systems or sewer systems; Haitians use streams and other untreated water sources for their drinking water, for bathing, for laundry, and for other bodily functions, often in the same place. Tent camp populations are especially vulnerable because of a lack of clean water, adequate latrines, and medical care. Cholera is a waterborne disease, and spreads during the heavy rains of the hurricane season.

The response of the international community to the cholera outbreak has been inadequate, Perito said. The International Organization for Migration announced that it had distributed 10,000 cholera kits, which contain

rehydration salts, Aquatabs,® and chlorine, in 31 camps. But with more than 500 camps in Haiti, the vast majority has not received the kits. The international community also has been building temporary clinics, distributing soap and bottled water and treating cases that come to their facilities. But these are short-term responses that do not address the basic problems of people living in the camps.

According to Perito, Haiti needs a comprehensive plan for health care delivery in both urban and rural areas. But because of a lack of jobs, education, and health care, people continue to leave the countryside and move into the camps around Port-au-Prince.

Finally, Perito looked at the problem of gender-based violence. Many women living in the camps are alone, having lost their families. The camps offer no privacy or physical protection, and the police presence is minimal if it exists at all. Historically, the slums of Port-au-Prince have been a locale for crimes, gangs, kidnapping, and random violence. In 2007 the UN military cracked down on the gangs, arresting their leaders and putting members in prison, but some 800 of these criminals escaped when prison guards abandoned their posts at the time of the earthquake. Most of them remain at large, living in the camps, where they have resumed their activities.

The international community's response to gender-based violence in Haiti has been inconsistent. Efforts have focused on making the camps safer, counseling women on how to avoid attacks, caring for rape victims, improving lighting, and increasing camp patrols. All of these are useful and help in the short term, Perito said, but they do not solve the basic problem of living in a tent in the camps.

Haiti's homelessness, illness, and gender-based violence result from a failure of governance and a lack of international coordination, Perito concluded. After the earthquake, the international community pledged almost $10 billion, and an interim Haitian reconstruction commission was formed. But then Haiti went through another convulsion of political violence, and the elections in November 2010 were disputed. A president finally emerged in March 2011, but there has been a continuing standoff between the president and the parliament. Faced with this uncertainty, international donors stepped back. As a result, the camps remain a problem, many institutions have pulled out, and donor fatigue is setting in. A long-term systematic solution will require planning, government buy-in, capacity building, international community coordination, and the creation of a development or reconstruction narrative.

BREAKOUT GROUP DISCUSSION

This breakout group selected as its objective to develop a method to understand the underlying reasons why the camps exist. That is, why does homelessness exist in Haiti? First, said breakout group reporter James Willis Jr., vice president of SPEC Innovations, the group identified several illustrative root causes of homelessness: weak governance and predatory elites as fundamental drivers, together with limited ownership opportunities and an inadequate supply of housing, caused in part by the destruction of buildings by earthquakes and hurricanes. The group did not pretend to have exhausted its analysis of the root causes of homelessness, but it agreed that with adequate information, such analysis could support actionable insights. The discussants also emphasized the importance of a holistic approach rather than separating analyses into silos.

To build the knowledge necessary for a full analysis, the breakout group suggested using a variety of technical approaches, including qualitative exploratory methods, case studies, simulations, and prototypes. For example, using prototyping to build out a knowledge base would require the construction of small group of houses in a particular location to assess costs and infrastructure needs. The group asserted that the use of such techniques would also require multidisciplinary expertise both during the planning and operational phases to enable application of systems engineering, modeling, and other integrated approaches.

Among the challenges to successfully addressing homelessness would be to gain buy-in from the elites that dominate Haiti. Whatever strategy were developed, it would need to benefit the homeless, the population of Haiti as a whole, and the elites. For example, the group wondered whether there is a way to redistribute land through a Homestead Act that could achieve widespread acceptance. They worried that land redistribution has great potential for violence—perhaps even greater than the violence now occurring in camps—but that without resolution of land tenure and ownership issues, there would be little incentive to dismantle these camps. Perito reported that many Haitians have a strong entrepreneurial spirit. Pride of ownership is part of this spirit. An emphasis on land ownership could also build on successful development programs that are already under way in Haiti.

As part of its consideration of method, the working group looked at what metrics might be needed to measure success. Of particular concern was the issue of data and of long-term access to those data. The working group thought that potential metrics might include available funding, sustainable economic growth, fewer people in camps, a reduction in disease, and

an increase in home ownership. The data needed to populate these metrics could be derived from information on NGO activities, lists of ongoing projects, and compilations of building activity.

The proposed analysis of homelessness could reveal latent capacity in the slums to address the problem. At the same time, though, it could also make more explicit the needs of the people living in the camps and their vulnerability (especially women and children subject to gender violence). With a better understanding of Haitians' own goals and priorities, programming can be designed to ensure buy-in to changes in land ownership.

The breakout group concluded that the lack of infrastructure and effective governance in Haiti must be addressed to achieve sustainable outcomes in national and international efforts to overcome the persistent challenges in the wake of the 2010 earthquake.

7

Takeaway Messages and Opportunities for Collaboration

The Workshop on Harnessing Operational Systems Engineering to Support Peacebuilding explored how operational systems engineering might facilitate peacebuilding. This final chapter compiles participants' observations into three broad categories:

1. Takeaway messages for representatives of peacebuilding-focused NGOs and government organizations about the basic techniques of operational systems engineering and how these techniques may aid improved decision making.
2. Takeaway messages for systems engineers about the world of peacebuilding and what types of peacebuilding problems might be amenable to systems approaches.
3. Opportunities for collaboration and further work between the peacebuilding and systems engineering communities.

Speakers who made particular observations are identified in parentheses.

TAKEAWAY MESSAGES FOR PEACEBUILDERS

Operational systems engineering offers new and powerful ways of analyzing conflict situations and arriving at ways to address them. A prominent characteristic of engineering is to start from a goal and work backward to fig-

ure out how to achieve it, which suggests that the application of operational systems engineering to peacebuilding is a natural fit. (Dan Mote, University of Maryland)

Modeling is key to operational systems engineering, which requires identifying the actors in a situation and the dynamics among them. (Ricigliano) In its analysis of food security in South Sudan, for example, the breakout group cited individuals, food production systems, education, infrastructure services, security forces, tribes, NGOs, governments, and the international community as just some of the actors that need to be included in a systems map of the country. Figuring out ways to do this quickly and effectively may be a critical element of successful systems approaches to peacebuilding. (Reynolds)

Systems engineering also requires moving beyond the construction of maps of causal relationships to the development and elaboration of models that can be improved through data gathering and hypothesis testing. (Ricigliano) Adoption of systems methods will require that peacebuilding organizations become more process oriented in their peacebuilding activities. (Cole) System-based simulations could enable peacebuilders to test different intervention strategies and understand what the most likely outcomes for each strategy are. (Robinson)

Operational systems engineering can be applied to peacebuilding at multiple levels, from the project or field level to the level of overall policy or oversight—there is no "right" level at which to apply it. (Worthington) At the broadest possible level, for example, analysis of the entire peacebuilding community could reveal how to make the sum of peacebuilding efforts greater than the constituent parts, in that separate projects would reinforce each other and contribute to broader objectives. (Rouse) A global model could focus local decisions on high-leverage areas, resulting in change to the overall system. (Ricigliano) In this way, systems engineering could bring a paradigm shift to peacebuilding in which the objective of peacebuilding is long-term systemic change. (Ricigliano)

TAKEAWAY MESSAGES FOR SYSTEMS ENGINEERS

Developing models for peacebuilding and arriving at proposed actions requires a strong understanding of local conditions. Local knowledge, participation, and ownership are essential to understand the context of a conflict and to reduce violence. Ultimately, societies must heal themselves by coming together to enable a future that is not based on conflict. (Worthington)

Models need to start simple and add complexity, testing during development against historical examples and current realities. Greater complexity can then be added, with further testing of model validity. (Hamner) Component subsystems, such as the effects of poverty on the progression of conflict, can be identified and studied as necessary elements of larger models and as test beds for systems engineering in peacebuilding. (Morris)

Focusing on specific problems, such as the ones examined at the workshop, provides a way of exploring and elaborating on the application of operational systems engineering to peacebuilding while also yielding concrete recommendations for action. Field tests of specific applications of systems engineering could demonstrate the viability of an approach. (Shelby) Discussion of specific problems also provides an effective way to improve dialogue among parties.

The application of operational systems engineering to peacebuilding will have to accommodate the development of data in a context in which resources on the ground are focused on interventions, not data collection. It must be emphasized that in a conflict environment the need to protect data and sources is paramount. Identification and prioritization of data needs may constitute an important early use of models.

OPPORTUNITIES FOR COLLABORATION

The development of models will require collaboration and iteration between peacebuilders and systems engineers. (Ricigliano) This process will reveal biases on both sides and compel participants to see systems as they really are rather than how they perceive them to be. (Himelfarb)

Participants at the workshop were particularly optimistic about the test cases. Each of the case studies examined could be extended and deepened. (Morris) In Kenya, a statistical history of election violence could be analyzed to mitigate future violence. In South Sudan, the analysis of data at different levels of societal organization could enhance food security. In Haiti, analysis of the reasons for homelessness could improve the lives of people living in tent camps. These efforts would offer fertile ground for testing the application of operational systems engineering to specific peacebuilding needs.

Successful applications of operational systems engineering to peacebuilding will require broader resourcing. Expansion of the breadth of NGOs represented at the workshop would provide additional perspectives and data for systems analyses while also bringing new perspectives to those organizations. (Morris) The collaboration among groups at the workshop could be

expanded through additional meetings or through the arrangement, by the NAE or USIP, of specific collaborative projects. (Cherry) Partnerships among organizations and the development of networks will be essential in a world of expanding capability but limited resources. (Worthington)

Capacity-building initiatives that are currently under way could foster greatly increased collaboration. For example, systems approaches could be an important component of the activities carried out under the recently announced USAID Higher Education Solutions Network, which is designed to establish institutional partnerships that will create and leverage a virtual network of experts who will help USAID solve specific global development challenges. (Reynolds) In addition, the development of a peace technology innovation laboratory at USIP (in planning at the time of the workshop) will make it possible to explore the application of operational systems engineering to the full range of peacebuilding activities. (Himelfarb)

Both peacebuilding and systems engineering must build capacity to synthesize the two. Peacebuilding programs and curricula in colleges and universities will need to be reshaped to provide students with the quantitative and modeling skills necessary in applying systems analyses to complex societal problems. (Reynolds)

Appendix A

Agenda

Workshop on
Harnessing Operational Systems Engineering to Support Peacebuilding

A National Academy of Engineering/US Institute of Peace Workshop
November 20, 2012
The Keck Center of the National Academies
Room 101, 500 Fifth Street NW
Washington, DC

8:15 Welcome and Introductions
W. Peter Cherry, Independent Consultant, SAIC (ret.)
Samuel Worthington, President and CEO, InterAction

SESSION I: BACKGROUND AND OVERVIEW

8:30 Understanding Peacebuilding: Three Perspectives
Moderator: Sam Worthington

Presenters:
Beth Cole, Director, Office of Civilian-Military Cooperation, USAID
Kirby Reiling, Conflict Specialist, USAID
Sharon Morris, Director of Youth & Conflict Management, Mercy Corps

9:30 Understanding Operational Systems Engineering in Action
Moderator: Peter Cherry
Presenter: William Rouse, Alexander Humphreys Chair of Economics and Engineering, School of Systems and Enterprises, Stevens Institute of Technology

Discussant: *Robert Ricigliano, Director, Institute of World Affairs, University of Wisconsin–Milwaukee*

10:15 BREAK

10:30 Identifying Peacebuilding Challenges for OSE Approaches in Kenya, South Sudan, and Haiti

Moderator: *Sam Worthington*

Case Study Presenters:

Kenya—Scaling Nonviolent Elections

Presenter: Dorina Bekoe, Research Staff Member, Africa Program, Institute for Defense Analysis

South Sudan—Enhancing Food Security

Presenter: Timothy McRae, Food for Peace, USAID

Haiti—Mitigating and Preventing Violence in Haiti's IDP Camps

Presenter: Robert M. Perito, Director, Security Sector Governance Center, USIP

SESSION II: WORKING GROUPS FORMULATE ANALYSIS PLANS FOR IDENTIFIED PEACEBUILDING SYSTEMS ANALYSIS ISSUES

11:45 Review Target Systems Analysis Issues for the Working Groups and Guidance

Peter Cherry

12:45 Working Groups Session

Working Group A: Scaling Nonviolent Elections in Kenya

Chair: John Birge, Jerry W. and Carol Lee Levin Professor of Operations Management at the University of Chicago Booth School of Business

Working Group B: Enhancing Food Security in South Sudan

Chair: Stephen M. Robinson, Professor Emeritus, University of Wisconsin–Madison

Working Group C: Mitigating and Preventing Violence in Haiti's IDP Camps
Chair: Alfred Blumstein, University Professor and J. Erik Jonsson Professor of Urban Systems and Operations Research, Heinz College, Carnegie Mellon University

3:00 BREAK

SESSION III: REPORT OUT OF WORKING GROUP DISCUSSIONS

3:15 Working Group Reports and Discussion
Moderator: Sam Worthington

SESSION IV: ISSUES, OPPORTUNITIES, AND POTENTIAL NEXT STEPS

4:15 Lessons Learned and Paths Forward
Peter Cherry

5:30 Adjourn

Appendix B

Attendees

NA-USIP Roundtable:
Workshop on Harnessing Operational Systems Engineering to Support Peacebuilding
of the National Academies and United States Institute of Peace

November 20, 2012

Keck Center of the National Academies
500 5th Street NW, Room 101
Washington, DC

PARTICIPANTS

Co-Chairs

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Independent Consultant
SAIC (retired)

Sam Worthington
President and CEO
InterAction

Steering Committee Members

Bernard Amadei
Founder, Engineers Without Borders
Mortenson Chair in Global Engineering
University of Colorado

Sharon Morris
Director of Youth and Conflict Management
Mercy Corps

Robert Ricigliano
Director, Institute of World Affairs
University of Wisconsin–Milwaukee

William Rouse
Alexander Crombie Humphreys Chair in Economics of Engineering
Stevens Institute of Technology

Expert Participants

Robin Amadei
Founder
Common Ground Mediation Center

Dorina Bekoe
Research Staff Member
Africa Program
Institute for Defense Analyses

Rodney Bent
Director
United Nations Information Center

John R. Birge
Jerry W. and Carol Lee Levin Professor of Operations Management
Booth School of Business
The University of Chicago

Alfred Blumstein
University Professor and J. Erik Jonsson Professor of Urban Systems and Operations Research
Heinz College
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Institute of World Affairs

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George Washington University

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United States Institute of Peace

Kirby Reiling
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