

# CeaseFire ABMS

SUMMARY REPORT

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## **Executive Summary**

This paper summarizes an agent-based model the authors developed to improve the ability of CeaseFire, a violence prevention organization, to stop shootings and killings in the communities it serves. Agent-based modeling is an analytical approach that uses detailed knowledge of the behaviors of large numbers of actors to derive the structure of a complex system. The authors created a participatory simulation which informed a computational simulation with NetLogo, an open-source modeling software. The model was verified and validated through comparison with observed real-world behaviors. The authors propose a more detailed model that would incorporate data from the CeaseFire archives in order to gain a clearer understanding of how CeaseFire workers impact violence.

## **ABMS**

Agent-based modeling and simulation (ABMS) is used to “increase the capabilities of experts to grasp micro-level behavior and to relate this behavior to macro-level outcomes” (North & Macal, 2007, p.7).

ABMS represents the activities of individual agents as a few simplified rules, then observes how those rules generate system-level behavior when independently followed by multiple actors. Whether the rules are represented as computer code or as a board-game-like activity for human participants, the model’s value lies in its accurate representation of the phenomena in question. Model development is best done incrementally, so that insights can be folded in early and iteratively, ultimately creating a tool for evolutionary learning.

## **CeaseFire**

CeaseFire aims to reduce the incidence of gun violence by hiring those formerly involved “in the life” (i.e. gang banging, drug dealing, stick-ups, etc.) to serve as “credible messengers” to spread the idea that conflicts can be resolved without violence. CeaseFire workers direct their efforts towards those at highest-

risk for being involved in a shooting and killing. Outreach Workers carry a caseload of 15 of these highest risk clients within their implementation area, serving as role models and helping young men and women to find alternatives to activities highly associated with gun violence. Violence Interrupters, while they have a similar background, serve a different role and cover a broader geographic area. They use their personal networks to identify potential conflicts so that they can intervene to negotiate a non-violent resolution between co-disputants before shots are fired or retaliation occurs.

CeaseFire’s day-to-day practice is driven by epidemiological methods that use data to better understand the nature and distribution of interpersonal violence. Each part of the intervention model relies on data collection to ensure the program’s effectiveness at reducing shootings and killings (Table 1).

**TABLE 1: CeaseFire Model and Associated Data and Monitoring**

Identification and detection	Interruption, intervention, and risk reduction using credible messengers	Change Behaviors and Norms
<ul style="list-style-type: none"> <li>+ Identify and detect:                             <ul style="list-style-type: none"> <li>- Potential shooting events</li> <li>- Individuals and groups at highest risk of involvement in a shooting or a killing</li> </ul> </li> <li>+ Use all sources and possible points of entry:                             <ul style="list-style-type: none"> <li>- Notice from law enforcement</li> <li>- Hospitals</li> <li>- Schools</li> <li>- Calls from community</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>+ Intervene in crises                             <ul style="list-style-type: none"> <li>- Help individuals deal with “in the moment” stressful events or situations without shooting</li> </ul> </li> <li>+ Mediate conflicts between individuals and/or groups                             <ul style="list-style-type: none"> <li>- Prevent larger scale events or retaliatory violence before it occurs</li> </ul> </li> <li>+ Provide ongoing behavior change and support to individuals using outreach workers and others                             <ul style="list-style-type: none"> <li>- Foster behavior change by providing information and skills</li> <li>- Connect clients to social services (e.g. education, job training and placement)</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>+ Inform and train individuals and groups on specific strategies to bring about behavior change</li> <li>+ Mobilize the community to change norms                             <ul style="list-style-type: none"> <li>- Organize responses to all shooting events</li> <li>- Sponsor community activities</li> <li>- Engage faith leaders</li> </ul> </li> <li>+ Education the public                             <ul style="list-style-type: none"> <li>- Launch and promote specific campaigns to enforce key messages and explain expected community roles</li> </ul> </li> </ul>
<b>Data and Monitoring</b>		
<ul style="list-style-type: none"> <li>+ Collect/analyze data from sources/points of entry (e.g. geo-coded homicide and shooting data)</li> <li>+ Evaluate clients based on high risk criteria</li> </ul>	<ul style="list-style-type: none"> <li>+ Monitor work (e.g. worker caseloads, # of interventions/mediations)</li> </ul>	<ul style="list-style-type: none"> <li>+ Measure outcomes (e.g. risk levels, shootings, change in norms) to inform approach</li> </ul>

Official data is collected from the police department to map shootings and killing to identify hot spots where the highest risk clients convene. Outreach workers and violence interrupters document their risk reduction

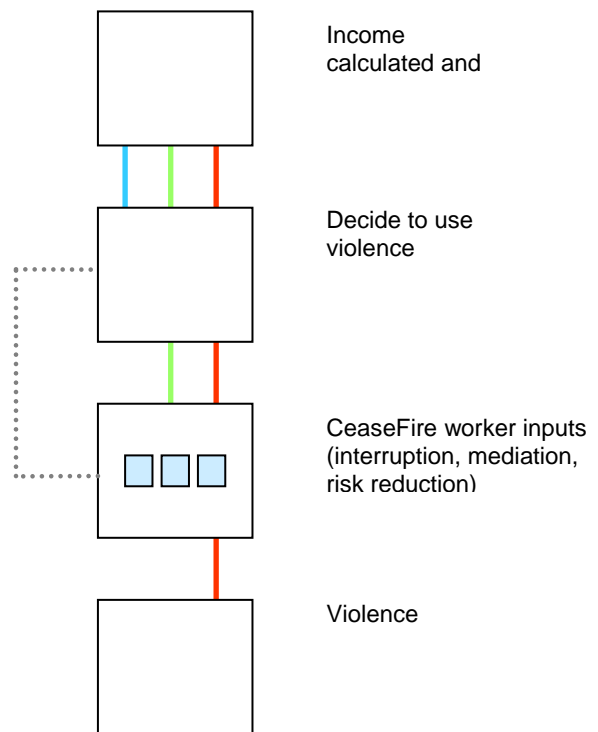
activities and mediations both to show their effectiveness and to reveal patterns of conflict. Program managers track public education and community mobilization activities associated with CeaseFire's goal to change behaviors and norms so that violence is no longer a normal or acceptable way to address conflict.

### CeaseFire ABMS Modeling

In order to guide CeaseFire's decisions about distributing its scarce resources and improving its effectiveness, the authors set out to create an agent-based model of a typical program implementation area. In the first phase of development, the authors created a participatory model focused on agents directly involved in violence related to the illegal drug economy, including gangs who perpetuate conflicts, CeaseFire workers who anticipate it, and police, who respond to the violence. The model focused on one of the most significant influences on urban violence: the drug trade. While other socio-cultural, personal, and economic factors affect an individual's tendency towards violence, the authors hypothesized that focusing on the relationships between gangs, law enforcement, and CeaseFire workers would provide a clear basis for understanding the impact of

interruption, mediation and risk reduction interventions. The second phase of development, informed by learnings generated from the in-class participatory simulation, consisted of creating and interpreting a computational version of the model in NetLogo. Both simulations feature four distinct activity stages (Diagram 1). In the first stage, Generals calculate earnings and pay the Leadership (blue line). If the income does not satisfy Leadership then Generals must decide whether to use

Diagram 1: Model Activity Stages



violence (green line). If risk reduction, conflict interruption and mediation inputs provided by CeaseFire workers are successful, a feedback loop to the General is created (dotted gray line) representing a change (in some cases temporary) in the General's level of aggressiveness and mindset about violence. If the CeaseFire workers' efforts (represented by blue boxes) fail, then the conflict escalates to violence (red line).

### **Verification and Validation**

Emphasis was placed on simplified assumptions about the relationships between and among agents as demonstrated in the participatory simulation; real data were not used to verify the model. The authors verified the model by systematically testing a range of variables and observing that the model's behavior matches the assumed outcome. In particular, this meant testing lower and higher values for the effectiveness and coverage of Outreach Workers and Violence Interrupters and observing--after some bugs were fixed—that higher effectiveness and coverage produced a lower incidence of violence. We validated the model by observing that some patterns of gang behavior, such as switching territories, were present.

### **Insights**

Some of the primary characteristics that jumped out were features of the model, rather than of the content. In particular, the authors assumed that a gang won't decide to attack when it is making enough money every week. Thus, we modeled a situation where one group is sated and stops attacking just when the other is most hungry and aggressive. This leads to the two groups trading ownership back and forth cyclically, bounded at the bottom by the "leader's weekly threshold" and on the top by the size of the map. Increasing the number of competing groups to three or more would reduce the likelihood that such a simple cycle would dominate the pattern of conflicts.

Based on a scan of the behavior space over several values for the number of outreach workers and the coverage of violence interrupters, the model produces a positive correlation between the coverage of CeaseFire workers and the number of "waiting" events. At the same time, in the runs with more waiting events there is not a consistent pattern of reduction in the total number of violence events. While the model

does not address the key benefit of waiting—letting individuals' emotional states cool down—this suggests more probing may be necessary into why it's an effective strategy for CeaseFire to counsel patience among its clients.

### **Opportunities to Extend the Model**

Validation and verification of the CeaseFire ABMS model would be further strengthened through the use of data to verify insights from the model. The next iteration of model development would include the data noted on the last row of *Table 1: CeaseFire Model and Associated Data and Monitoring* (p. 2) including, official beat-level police data for shootings and killings in CeaseFire zones; CeaseFire worker inputs (e.g. number of clients, number of home visits, risk reduction outcomes such as completion of GED, job attainment, etc.); and reductions or increases in shootings and killings by beat, over time, to determine CeaseFire's effectiveness.

The model could be further expanded by including agents and behaviors associated with CeaseFire's public education campaigns and community mobilization strategies that aim to change the thinking and social norms. They act at the community level to reinforce the message that shootings and killings are unacceptable. Public education campaigns are a traditional public health method used to influence changes in health behavior change. Campaigns require a significant capital investment in order to achieve market saturation through print media, radio and television coverage, and swag (excluding new and social media), yet there is relatively little evidence to demonstrate which of these channels is most effective with a given audience. Agent-based modeling, if augmented with further research into the public health literature to generate hypotheses about possible mechanisms for outreach effectiveness, could be a useful technique to better understand which channel for what audience and when.

Once CeaseFire agent-based model development progressed to include all of the agents and behaviors that comprise the intervention model—identification and detection; interruption, intervention, and risk reduction; and, changing behaviors and norms—the ultimate goal would be to apply behavior change

theories (e.g. Stages of Change, Ecological Model, etc.) to the agent-based model to explore how theory and CeaseFire practice interact and how these interactions affect the level of violence in the simulation environment.