A quantitative analysis method for crowd responses to non-lethal weapons (NLWs) has been developed. Using motion capture technology, the location and orientation of all individuals in a crowd were recorded during various engagements with a control force wielding simulated NLWs. The motion and behavior of the group, both as a whole and as individuals, were quantified using a variety of metrics derived from these measures. Several of the proposed metrics (average leading edge and streamlines) were sensitive to differences in critical characteristics of the scenario, such as weapon type (standoff vs. hand-to-hand combat) and rules of engagement (threat vs. no threat). Therefore, these metrics can be used to assess and compare effectiveness of different types of non-lethal weapons and systems and how weapon effectiveness varies with tactics, techniques, and procedures.
**TOPOLOGY AND INDIVIDUAL LOCATION OF CROWDS AS MEASURES OF EFFECTIVENESS FOR NON-LETHAL WEAPONS**

**INTRODUCTION**

Crowd management may be the prototypical military scenario that requires the use of non-lethal weapons. To prevent and manage possible crowd disturbances, non-lethal weapons need to be developed with tactics, techniques and procedures (TTP) for employment. However, to accomplish this goal, there must be a way to judge the effectiveness of different non-lethal weapons. Judgment of effectiveness requires understanding of both the behaviors that the war-fighter wants to induce using a non-lethal weapon and the crowd behaviors that will result from weapon use. To accomplish this goal, there must be a way to judge the effectiveness of different non-lethal weapons. Judgment of effectiveness requires understanding of both the behaviors that the war-fighter wants to induce using a non-lethal weapon and the crowd behaviors that will result from weapon use. To accomplish this goal, there must be a way to judge the effectiveness of different non-lethal weapons. Judgment of effectiveness requires understanding of both the behaviors that the war-fighter wants to induce using a non-lethal weapon and the crowd behaviors that will result from weapon use.

The human subjects were given a task of throwing a beanbag into one of three available targets that were placed on the opposite side of the target. The beanbag was thrown by the subjects’ numbers. After each trial, researchers recorded whether a subject’s beanbag hit the target, missed the target, or was not thrown. To increase their motivation, the subjects were given points if they were able to get their beanbags into a target. This task by itself was shown not to be very effective.

**METHOD**

The mission was to get the beanbags into any of the targets at the far end of the field than the group was rewarded with points and money. Individual points were also tracked with bonus money for the individual with the best score. The scenario was designed to induce subjects to go towards targets and to go away from the control force. The methods developed methods that described critical crowd behavioral response relevant to the mission’s mission, namely location orientation, and isolation of persons in the crowd. The paper describes the mathematical methods investigated to quantitatively describe crowds, group behavior of the crowd, and individual isolation within the crowd. These methods are fundamental to the analysis of effectiveness of non-lethal weapons in crowd scenarios.

**CONCEPTUAL FRAMEWORK**

The Target-Behavioral Response Laboratory (TBRL) program of Crowd-Based research utilizes the Field Theory as exposed upon by Kurt Lewin (1935, 1936), as a framework that guides design, conduct, and analysis of experiments. Predictions of the areas or goal regions to which people move can be made based on the tenets of field theory.

**RESULTS AND DISCUSSION**

This experiment investigated how the behavior of a crowd or group of multiple individuals could be expressed numerically. The data set used included 90 trials of data recorded from 5 groups, each made up of 12-17 individuals. The average leading edge can be obtained by combining the data from all the trials. The mean performance curve shows the behavior changed in a general sense. It can be seen that the two non-threat conditions are very similar, not allowing the leading edge quite as far forward and slightly delaying the advance, as well as the delaying the retreat. It can also be seen that the threat conditions there is a much lower peak of advance and almost no longer time at the closest approach. Under threat, the standoff weapon (green line) seems to keep the leading edge slightly further back than the hand weapons (red line).

**VECTOR FIELDS**

Streamlines were created from the vector fields for better illustration.