E27 Biomechanical Considerations in 3D Reconstruction of Shooting Events

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Learning Overview: After attending this presentation, attendees will learn how analysis of human motion can aid 3D reconstruction of shooting events.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by demonstrating how the accuracy and validity of 3D shooting reconstruction can be enhanced through surrogate studies.

3D computer modeling and animation software is an important tool in analyzing and illustrating shooting incidents because it allows us to accurately demonstrate the interaction between projectiles and objects in terms of time and space. Using 3D laser scanners, we can create highly accurate models of a scene. 3D models representing people, referred to as mannequins or character models, can be added to show the approximate body position of the person who was shot. Just as a pathologist places rods through a cadaver, lines can be added to depict bullet paths through the body of the mannequin.

One limitation of computer-generated mannequins is that they are not always able to replicate the body position or movements of a person. Computer models of people can be comprised of a series of articulated polygons or can be a mesh structure rigged with an internal bone system that deforms the mesh. In some situations, the mannequin will not accurately replicate how a real person bends, nor will it be limited to human range of motion. The mannequin's movements are controlled by the animator and may not accurately replicate human kinematics. Hollywood animators can create extremely complex and lifelike human models, which are controlled using motion capture data recorded from human actors. This level of sophistication with its associated cost is not often available to the forensic investigator.

In complex shooting events, it may be necessary analyze video of human subjects performing similar movements. Synchronized cameras can record surrogates from multiple angles as they attempt similar movements or body contortions. The video can then be analyzed frame-by-fame to derive motion data and body positioning, lending foundation to the accuracy of the reconstruction. A surrogate study may also reveal how surrogates approach a task or respond to stimuli.

This presentation will examine two officer-involved shooting incidents in which it was necessary to analyze the movement and positioning of surrogates performing certain tasks. In one case, an officer opened the door of her patrol car when she arrived at the scene of an alleged kidnapping attempt. A male suspect ran toward her car and jumped inside the vehicle on top of her. The officer fired two shots, striking the suspect in the shoulder and back. In analyzing the incident, surrogates were used to recreate the incident. A male surrogate ran toward a vehicle with an open car door and attempted to grab a female surrogate inside. Video analysis of the reenactment showed that when the male surrogate approached the vehicle, he slowed his pace and reached out with his right hand to brace himself against the B-pillar of the vehicle. He then dropped his left shoulder and led with his left arm as he ducked inside the open car door. This motion created the correct positioning for the shot angles to occur. The muzzle-to-target distances were consistent with stippling found on the body and blood spatter in the vehicle correlated with the location and orientation of the suspect's wounds.

In another case, an armed suspect was jumping over a backyard garden fence when he was shot by a police officer. The bullet entered the buttocks and traveled upward through the torso into the left chest. The bullet appeared to change direction, laterally, ending up in the left shoulder. There was what appeared to be an exit and reentry wound in the area of the left shoulder, suggesting the possibility that the suspect was shot while on the ground. As part of the analysis, surrogates were videotaped jumping over a similar fence. The surrogate study showed that there are numerous ways a person can approach and launch their body over a fence. However, going over headfirst, with one's left arm extended, created an alignment between the shoulder and the bullet path through the torso. It also created a crease in the skin that would explain the unusual shoulder wound.

Shooting Reconstruction, Biomechanics, 3D Modeling