BIOMECHANICS of LETHAL FORCE ENCOUNTERS
OFFICER MOVEMENTS

By Bill Lewinski, Ph. D.
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It is my intent to investigate the dynamics and biomechanics (the mechanics of biological and muscular activity) that occur in officer-involved shootings in a series of research studies. The first of the series started with measuring subject behavior in shooting situations (**The Best of the Police Marksman, Vol., II. See page 5**). The next phase starts with determining and measuring the fundamentals of shooting motions that officers perform in lethal force encounters. I'm aware that officer behavior in shooting situations can be much more complex than the elementary mechanics of drawing and firing or moving and firing that are measured in this study.

However, the reaction times, sight times, and movement times need to be studied, because often they are the only things officers do in shooting situations. Sometimes they form the components of more complicated motions and need to be fractioned out if we are to more fully understand the more complex motions. For instance "lag time" is comprised of a variety of biomechanical motions that officers perform in lethal force encounters; it's difficult to isolate the more complex and profound psychological dynamics, such as perception and judgment time. These other elements, of course, need to be studied and it is my intent to do so, after the physical elements are measured.

The primary purpose of this study is to measure the time it takes to do certain motions. This is not the definitive study on the movements and times of officers in lethal force encounters. However, it is very comprehensive. While the complete research design and a full analysis will not be presented here, it is important to know that a variety of measurements were taken on 68 officers from different sections of the Los Angeles Police Department. Testing was done at one of the ranges at the Davis Training Facility. The officers performed movements on the range that either form the foundation of, or are the components of the movements that officers perform in shooting situations or they directly replicated those movements.

For instance, the officers performed motions that allowed me to separate reaction time, movement time and sighting time as separate components of the full shooting motion. The same movement was sometimes also studied from a number of perspectives. For instance the officers were asked to place their finger on the trigger and react to the stimulus from a PACT timer by pulling the trigger – unsighted, sighted, and finally, the sighted reaction of the first round when the officer was asked to fire three rapid rounds in reaction to the timer. Each officer did this many times. This meant the following three elements could be isolated – the simple trigger pull reaction time, the trigger pull reaction time when the weapon was sighted on target, as well as the first trigger pull reaction time when the officer was sighted on target and was set to fire a series of three rounds. Doing it this way then allowed me to draw out of the data the precise time it takes and officer to acquire a sight picture when the weapon is already pointed in the general direction of the target, and determine the time required to fire a second and third round in a series of three sighted rounds. It also allowed me to determine whether the firing of multiple rounds had an impact on the first round fired. Example: if the officer is set to fire multiple rounds, does it change the reaction time of the first round?

The sidebar at the bottom is a straightforward presentation of the research results. The only number presented is the average time for each of the motions. Follow up articles in *The Police Marksman* magazine will present a more comprehensive analysis of the data and examine the implications of the data for officer safety, tactical issues and ultimately an examination of how this data and my previous research on subject movement in shooting situations can help us understand and explain the biomechanics of lethal force encounters. The data has already been analyzed by an SPSS program and will also be presented at a scholarly-refereed conference and in a refereed conference and in a refereed journal.

When evaluating the data, the reader needs to understand that the LAPD has a significant focus on target accuracy in both pre-service and in-service training. Regardless of the motions the officers were asked to perform, they were always working, when possible, for a sight picture before discharge. Also, the LAPD does not train or endorse certain of the motions measured in this study, such as the Hollywood High Guard position, but the officers, performed those motions for the benefit of the study.

All of the actions requiring a sight picture were done on the 5-yard line. All unsighted activity was done at the 3-yard line. The weapons involved were mostly 9mm Berettas and 45 Caliber Smith and Wessons. A breakdown by weapons is not provided for each of these activities but will surface in future articles. (See charge at the end of article).

Observations:

This study is dense with information and offers some interesting data. For example: If a weapon is pointed at a target, it takes 3/100^{ths} of a second to confirm or set the sight picture, before the officer pulls the trigger, if the officer already has his finger on the trigger. If the officer has the finger indexed or on the frame and the weapon is pointed at the target, the time to confirm or set the sight picture is 9/100^{ths} of a second before he completes the trigger pull.

I think it is fascinating that the time to move from a low-ready position and a tactical low-ready position to a sight position and fire on round is the same for both actions. This appears to defy logic, but it is the case. This is because developing momentum and acquiring a sight picture are the two time-expensive components of both of these motions. Once the officer's arm and weapon develops momentum, moving a distance of 6 to 22 inches was not a significant element in the overall time of either motion. So much effort and time is invested in getting the motion started and then stopping it as the weapon comes on target, and then taking the time to get a sight picture and pull the trigger, that the time to travel up to 22 inches is actually negligible in the overall measurement of either motion.

Another incidental observation is the amount of time it takes to draw from a variety of holsters. It is significant however that one of the fastest draws and the slowest draws occurred from a level 3-duty holster and were directly linked to the amount of practice the officer had with that holster.

It is my observation from the data that the fastest draw occurs from a level one-duty holster. But, more significantly, the greatest factor in the speed of the draw is the amount of time the officer spends practicing with that holster. For instance, the average time to draw and fire one round with a sight picture from a level 1-duty holster is 1.71 seconds. One of the officers with a level 3-duty holster was able to draw and fire one round in 1.37 seconds.

Another illusion is that the unsnapped holster is a faster draw than a snapped holster – certainly, many officers have proven this to be true. However, quite a few officers using all levels of holsters actually drew slower from an unsnapped than a snapped holster. The really skillful officers drew at approximately the same time or slower from an unsnapped holster as they did from a snapped holster. For instance, the officer who pulled and fired one sighted round from a snapped level 3-holster in 1.37 seconds, also pulled and fired one sighted round from an unsnapped holster in 1.42 seconds. Many officers said they did the same biomechanical motion, whether the holster was snapped or unsnapped, thus negating the benefit of unsnapping the holster. Other officers said it took them longer to draw from an unsnapped holster because the weapon didn't quite sit in the holster as solidly as if it were snapped in, and was subsequently harder to grasp.

Therefore, the time for confirming the grip on the weapon negated the time advantage of unsnapping the holster. The more unskilled officers were clearly the ones who drew faster from the unsnapped holster. Ironically these unskilled officers may also be the least skillful in retaining and using their weapon from an

unsnapped holster. An analysis of the overall data indicates the time benefit of unsnapping the holster varies from 6 to11 percent, based on the nature of the holster. A level 1-duty holster has a 6% advantage in speed for the unsnapped holster, while for a level 3-holster, the unsnapped holster had an 11% speed advantage over the snapped. This is a very meager gain in speed for a major loss in officer safety. A gain of 6-11% in speed in the draw could easily be made up by simply practicing drawing the weapon with speed, an extra three to five times per week, for a relatively brief period of time.

Another interesting observation that may relate to an illusionary belief is that an officer will gain a lot of speed by taking the weapon out of the holster and hiding it behind his thigh in a bootleg position. The comparison of the time to draw from a bootleg position to a sight picture and fire – versus drawing from a level 1-duty holster to a sight picture and fire – is 4/10^{ths} of a second in favor of shooting from the bootleg position. This is also the time difference between shooting in a combat tuck/close contact position from a bootleg position, and also shooting in a close contact/combat tuck position with a holstered weapon, in level 1 duty holster position. Therefore we can conclude that it doesn't matter which motion the officer makes with the weapon, it is generally 4/10^{ths} of a second faster out of the bootleg position than out of the holster. The reader might also note that any motion from the bootleg position (even the close contact/combat tuck firing position) is obviously much slower than even the 45 degrees, academy trained, low ready position. Again, as with the snapped versus unsnapped holster issue, the officer needs to seriously consider the tactical advantage of a gain of 4/10^{ths} of a second versus the tactical advantage of having the weapon in a secure holster.

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About the Author

Dr. Bill Lewinski has a doctorate in Police Psychology from Union Institute in Cincinnati, Ohio. He is a professor in the Law Enforcement Program at Minnesota State University, Mankato, Minnesota. He is an ex-lecturer and contributing expert to the Street Survival Seminars and the Tactical Edge.

See Data Chart Below

All of the following data is measured in hundredths of a second
All of the motions were reactions to a buzzer from PACT timer.

1. Finger on trigger – simple, unsighted, reaction time - .35
2. Finger on trigger with a sight picture, reaction time - .38
3. Finger on frame – simple, unsighted, reaction time - .45
4. Finger on frame with a sight picture, reaction time - .54
5. Time to fire a second round in a series of three (with sight picture) - .38
6. Time to fire a third round in a series of three (with sight picture) - .36
7. Weapon in low-ready position (45 degree angle) with the finger on frame, raise the weapon, acquire sight picture, fire one round - .83
8. Weapon in tactical or a high/low-ready position with the finger on frame, raise the weapon, acquire sight picture, fire one round - .83
9. Time to move the weapon from the low-ready position on target - .64
10. Time to acquire a sight picture after moving the weapon from between 6 to 22inches to a position on target - .18
11. Close-ready to sight picture and fire – 1.0
12. Belt-tuck to sight picture and fire – 1.0
13. Hollywood high guard to sight picture and fire – 1.1
14. Bootleg position to a sight picture and fire – 1.3
15. Bootleg position to close contact (combat tuck) position and fire - .92
16. Draw and fire on round (start position was from, hand at the side of the body near the holster, weapon in holster, either snapped or unsnapped.)
    - Level One Holster – off duty (snapped) – 1.87 (unsnapped) – 1.71
      On duty (snapped) – 1.71 (unsnapped) – 1.61
    - Level Two Holster - (snapped) – 1.92 (unsnapped) - 1.72
    - Level Three Holster – (snapped) – 2.00 (unsnapped) – 1.78
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17. Draw and fire one round from close contact/combat tuck position (start position was from hand at the side of the body near the holster, weapon snapped in holster)
    - Level One off duty – 1.50
    - Level One on duty – 1.31
    - Level Two – 1.51
    - Level Three – 1.70
18. Shotgun – from port to point and fire – 1.28
19. Shotgun – from low-ready to point and fire - .98
20. Shotgun – from high-ready to point and fire - .84