BLAKEY NARRATION: TRAJECTORY

Tuesday, September 12, 1978

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Bullet trajectory has become a matter of considerable debate in the Kennedy assassination, for it, too, goes, as the testimony has indicated, to the heart of the issue of whether a single bullet wounded both the President and Governor Connally. It also locates the position of the assassin or assassins whom the medical evidence indicates hit their target.

sic!

The Warren Commission reasoned that an accumulation of medical and ballistics evidence demonstrated that the shots were fired from the sixth floor of the Texas School Book Depository. Its approach to the line of fire issue, therefore, was simply to determine that trajectory data was consistent with this conclusion.

On May 24, 1964, FBI and Secret Service agents conducted a series of tests, reconstructing trajectories. Using the Zapruder, Nix and Muchmore films, they were able to fix the locations of the presidential limousine and its occupants. An FBI agent was positioned in the southeast corner window of the sixth floor of the TSBD with the Mannlicher-Carcano that had been identified as having belonged to Lee Harvey Oswald. Mounted on the rifle was a motion picture camera attached to the telescopic sight that viewed the target area precisely as

the assassin would have seen it had he used the telescopic sight. The position of the limousine, as it corresponded to each frame of the Zapruder film, was recorded.

The agents observed that at frame 166 of Zapruder, the President passed behind the foliage of an oak tree, and but for a fraction of a second at frame 186, he did not move into an assassin's view until frame 210. This led the Commission to accept the probability that the President was not shot before frame 210. The assassin, the Commission reasoned, would have waited until after frame 210, at which point his view was again unobstructed.

At frame 210, however, Abraham Zapruder's view of the President was blocked by a highway sign, and he did not emerge from behind the sign until frame 225, just short of a second later. Although the Commission was unable to fix the exact time point the President was first hit, it was able to determine it was during the period he was behind the sign. The Commission thought he showed no sign of injury before frame 210; he was obviously hit at frame 225. It should be emphasized, however, that there is no photographic evidence recording the precise instant of the first hit to the President.

Still, the Commission proceeded to plot the trajectory of the first shot to hit the President by assuming the position of the limousine to be between frames 210 and 225. At each

intervening frame, the FBI agent at the sixth floor window lined up the telescopic sight on the points of entry wounds marked on stand-ins for the President and Governor Connally seated in the limousine.

The next step was to have a surveyor place his sighting device at the precise point of entry on the President's upper back for each frame of the Zapruder film. The surveyor then measured the angle to the muzzle of the rifle in the sixth-floor window of the TSBD. The measurements were averaged, and, taking into account the downward grade of the roadway, the probable angle through the President's body was calculated at 17 degrees, 43 minutes, thirty seconds, assuming he was sitting in a vertical position.

The commission then concluded that this angle was consistent with the trajectory of a bullet that would have passed through the President's neck and struck Governor Connally in the back.

The critics have decried the commission's trajectory for the fact that it assumes the shot came from the rear. Here are samples of their commentaries:

Mark Lane in his Rush to Judgment: The commission ". . . employed the unproved assertion that the bullet which struck the President came from the rear as a basis premise to prove that it 'probably' hit Governor Connally as well."

Sylvia Meagher in her Accessories After the Fact: The commission did not give "adequate consideration to the possibility of assassins at locations other than the window or the overpass. . .There is a considerable body of evidence suggesting that shots were fired from the grassy knoll. . ."

Josiah Thompson for his Six Seconds in Dallas attempted a trajectory analysis and decided there were four shots from three locations -- two from the Depository, one from the east side of Dealey Plaza, one from the stockade fence north on Elm Street.

It would seem the critics have at least one point in their favor in attacking the commission's analysis: It assumes the firing position of the assassin as a "known," then proceeds to compute the angle to the target. The objective was to verify that the resulting trajectory was consistent with the assumed position of the gunman.

The committee took quite another approach. It decided to take the entry wounds to the President and Governor Connally as the starting points in its calculations and working outward from there. It was hypothesized that, given a margin or error, the trajectory back from the limousine would lead to the position of the assassin.

The committee in part based its trajectory analysis on the location of entrance and exit wounds supplied by its medical panel, and it relied on evidence obtained from photographic and accoustical analyses. (Since the trajectory study was underway

well before the acoustics analysis was complete, data on the sound of shots was available only in the latter stages of the line-of-fire survey. It is likely + (IT SHOULD BE EMPHASIZED) that the final trajectory analysis will be modified somewhat in order that the final results of the acoustics analysis might be incorporated.) TODAY'S TESTIMONY IS PRELIMINARY IN THAT SENSE.

For the photographic phase of the survey, the committee called on 15 MAN odd photo scientists who served either as contractors for the committee or as members of its photographic panel. At a recent conference, they reviewed the Zapruder film from two standpoints: first, they sought to pinpoint when the President and Governor Connally first visibly reacted to being hit by shots; second, they tried to determine whether the relative position of the two men at the moment Kennedy was thought to be first hit is consistent with the single bullet hypothesis.

The photo scientists who did the review represent a broad range of experience, both academic and industrial. Their work for the committee has been extensive since, as the presentation on opening day indicated, the photographic issues in the Kennedy assassination are many and complex.

A member of the photographic evidence panel, Mr. Calvin McCamy, is here to testify on the part of the trajectory analysis that utilizes the Zapruder film. He will also discuss the photogrammetric technique that was used to locate precisely the position of the limousine at the time the shots that struck the President and Governor Connally were fired.

Mr. McCamy received a B.S. degree in chemical engineering and a M.S. degree in physics from the University of Minnesota.

He has taught mathematics at the University of Minnesota and physics at Clemson University. He has been chief of image optics and photography with the National Bureau of Standards. Currently, he is with the Macbeth Division of Kollmorgen Corporation.

Mr. McCamy serves as chairman of the American National Standards' Working Group on Print Quality for Optical Character Recognition, chairman of the American Society of Photogrammetry Standards Committee and advisor to the U.S. delegation to the International Organization for Standardization Committee on Photography.

Mr. McCamy is a fellow of the Optical Society of America, the Society of Motion Picture and Television Engineers and the Society of Photographic Scientists and Engineers. He serves on the editorial review boards of several technical journals and he has authored numerous papers on photography, color printing and other aspects of chemistry and physics.

It would be appropriate now, Mr. Chairman, to call Mr. McCamy.

The trajectory analysis itself was a joint effort between the committee and the National Aeronautics and Space Administration. An engineer with NASA's Space Projects Division, Tom Canning, constructed the final product from information provided by the committee.

Mr. Canning received a B.S., cum laude, in mechanical engineering and an M.S. in aeronautics from Stanford University. Since joining NASA in 1943 as an aeronautical research scientist, he has been Branch Chief of the Hypersonic Free-Flight Branch, Group Leader for the Probes System Group of the Pioneer-Venus Mission, and currently he is Staff Engineer of the Space Projects Division.

Mr. Canning received the NASA Medal for Exceptional Scientific Achievement for his work in atmosphere entry body research for Mercury, Gemini and Apollo. During his 23 years of work with the Hypersonic Free-Flight Branch he has conducted and supervised research in the flight trajectory and stability of high speed projectiles and missiles. He has published numerous papers in that field.

Mr. Chairman, it would be appropriate now to call Mr. Canning.