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UFAK Assassination Unfolds in LightWave Re-creation

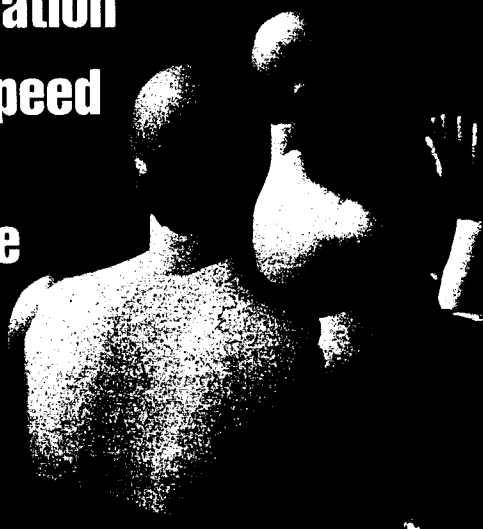
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VIDEO TOASTER USER

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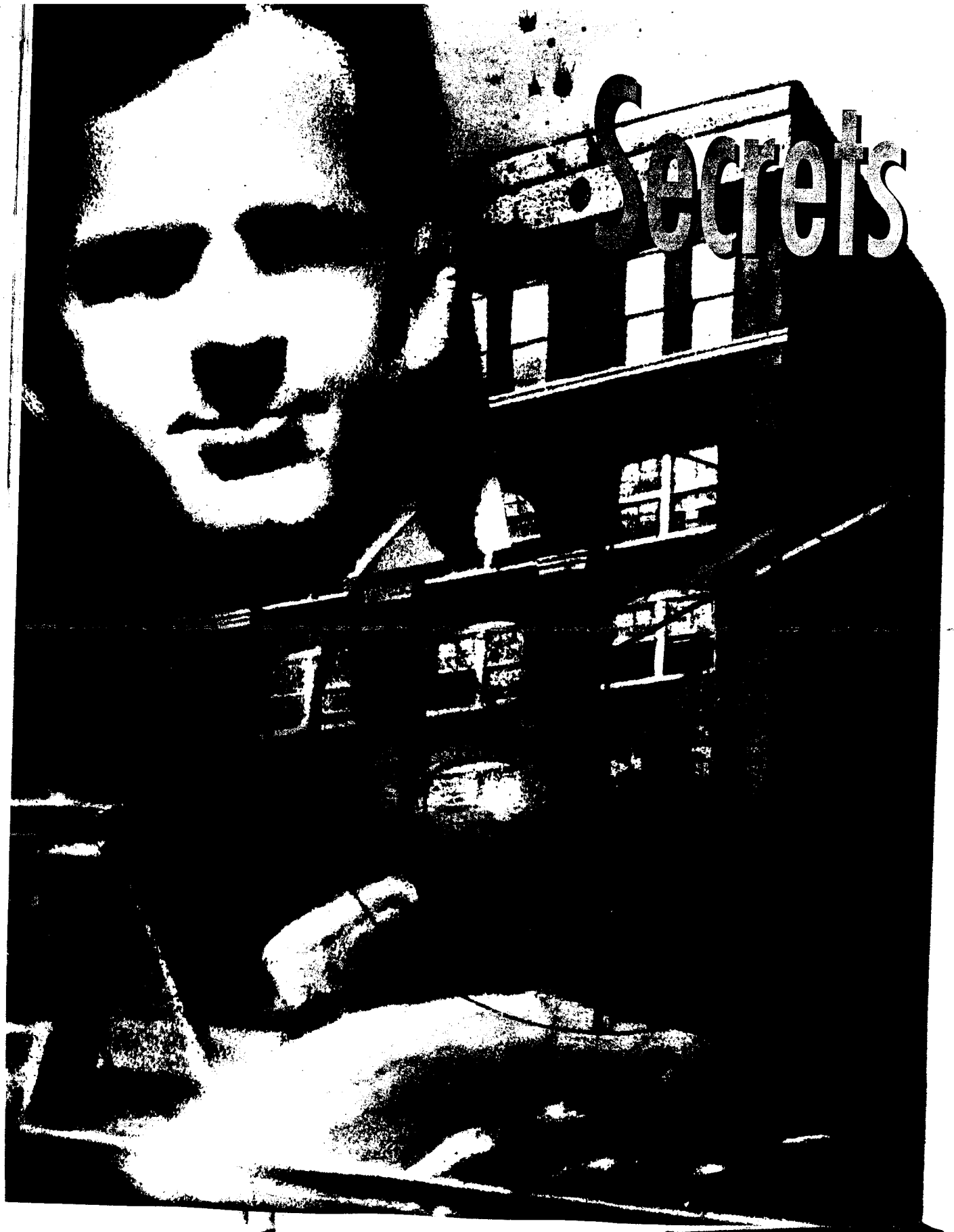


Cover Image by Dale K. Myers

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of a Homicide: Exploring the JFK Assassination

by Dale K. Myers

In the summer of 1975, radio announcer Dale Myers had an opportunity to see a bootleg copy of the Zapruder film, the famous 8mm home movie depicting the assassination of John F. Kennedy on Nov. 22, 1963. That moment changed his views on the murder of the 36th President of the United States. Over the next 20 years, Myers searched the indices of the National Archives in Washington, D.C.; prowled the corridors of the Texas State Archives in Austin, Texas; and visited Dealey Plaza, site of the assassination.

As a bonafide "expert" on the assassination, Myers was instrumental in the release of nearly 5,000 documents from the FBI and CIA under the Freedom of Information Act, produced a 1983 radio documentary that was honored by the Associated Press, wrote the Detroit News' 25th anniversary coverage of the assassination, and served as technical consultant both in front of and behind the cameras of the critically acclaimed 1993 BBC/Frontline television special Who Was Lee Harvey Oswald? Now an award-winning computer animator, Myers explores the JFK assassination in a new documentary.

They say that if you were to study a single subject for one hour a day, in five years time you'd be a leading expert on that subject. If you were to spend 20 years time, you'd have a compelling urge to write a book. So far, I've been able to resist that temptation.

For me, the JFK assassination has always been a visual event. In fact, it is arguably the most photographed murder in history. Eyewitnesses I've spoken with over the years have repeatedly proven that there's truth in the old cliché "you had to be there." Yet, on November 22, 1963, events occurred so quickly that witnesses were unable to record the intricate details we now need to solve this three-decade-old mystery. If only we could somehow time travel to Dallas and preserve, for the official record, those details that have since eluded historians. Perhaps then, the assassination wouldn't be so mysterious.

In 1990, after embarking on a career in computer animation, I found the time machine I had wished for in the form of LightWave 3D.

Applying computer animation to the JFK assassination is not a new idea. PBS's NOVA program included a crude wireframe computer rendering of the assassination site in a 1988 TV special hosted by Walter Cronkite, while Failure Analysis Associates, Inc. produced an improved computer version of the plaza in 1992. Yet both renderings focused on a single issue, the trajectory of the shots fired at Kennedy's motorcade. I wanted to go beyond this focus.

Secrets of a Homicide

The result is *Secrets Of A Homicide*, a half-hour computer-generated exploration of the crime of the century. The concept was simple: rotoscope the Zapruder film into a 3D-animated model, then re-film the entire event from multiple viewpoints using high-resolution cameras. Through computer imaging, viewers would step back in time to become witnesses to the JFK assassination.

Secrets Of A Homicide is a crime scene re-creation on a monumental scale. I knew that if the final renderings were to have any evidential value, the crime scene setting demanded historical accuracy and mathematical precision.

Creating Dealey Plaza

To begin, I studied a survey map of Dealey Plaza that was prepared by Drommer and Associates for the 1978 House Select Committee on Assassinations.

Dealey Plaza is a triangular-shaped park area at the edge of Dallas' downtown business district. It is bordered on the east by Houston Street and the west by a railroad bridge known as the Triple Underpass. Cutting through the plaza are three roads—Elm, Main and Commerce—that sweep down a three-degree grade and slice under the Triple Underpass. To keep a reasonably low polygon count, I decided to model the north side of the plaza, do a mirror image, merge the two halves, and then trim the south end of unnecessary polygons.

The survey map provided precise elevations and locations of the plaza's main features—sidewalks, streets, lampposts, sewers, monuments, buildings and

Secrets of a Homicide

trees. Since the survey was conducted 15 years after the assassination, it was important to use 1963 photographs of the plaza in placing objects that had since been relocated, such as streetlamps and highway signs.

Before beginning the process of modeling, all survey map measurements were translated into numbers that LightWave Modeler could use. Utilizing the southeast corner base of the

Texas School Book Depository as the zero point (0,0,0), I converted all of the elevation points into X-Y-Z coordinates.

Modeling Elm Street

To create the sweeping grade of Elm Street, points were entered into Modeler that matched the survey elevation coordinates taken along the top of the north curb. These were linked together into a spline path. The survey map showed that the 40-foot-wide roadway rose approximately six inches between both gutters. Using survey points, a spline curve was

created to match this hump in the road. The spline was frozen using Modeler's Freeze function and the point count was reduced to something more manageable: Using information from other official sources, a cross-section of the sidewalk, curbs and street was created and positioned at the head of the spline curve that represented the sweeping curve of Elm Street. This cross-section was then extruded along the spline path using Modeler's Path Extrude feature to produce a perfect replica of Elm Street (Figure 1).

Similar techniques were employed to create the sidewalks, curbs and streets of Houston and Commerce. Finally, all of the modeled roadways were joined into a single object. Using the road as a template, I mimicked all of the street markings—crosswalks, centerline, road stripes—seen in 1963 photographs of the plaza. These polygons were burned into the road surfaces using Modeler's Template Drill/Stencil feature.

The monument walls, pergola, peristyle and reflecting pool that populate Dealey Plaza were modeled from personal photographs I had taken during various trips to

Dallas between 1981-89, along with measurements provided by the JFK research community. Modeler's Boolean and Bevel functions proved invaluable for the creation of these objects, which were placed at elevations gleaned from the Drommer and Associates survey map.

Forming the Landscape

At this point, I essentially had the streets and monuments of Dealey Plaza floating in space. Next, I had to fill in the spaces with a contoured landscape. I plotted points matching the sloping ground at 30-foot intervals, producing a rough spline cage that represented the grounds of the plaza (Figure 2). The cage was meshed using Modeler's Patch function. Where more detail was needed, the polygon mesh was Tripled and Subdivided, then manipulated using the Magnet tool. Finally, the landscape was hand-stitched to the surrounding roadway and monuments.

The ornate lampposts that follow Elm, Main and Commerce streets were lathed from photo-based outlines. Highway and traffic signs were created by burning traffic symbols into basic sign shapes using Modeler's Template Drill/Stencil feature.

Growing Trees

The toughest aspect of modeling Dealey Plaza was the issue of trees. It's nearly impossible to create a realistic-looking tree in any modeling program without an incredible amount of polygons—something I really couldn't afford with this model. Although some realistic tree generation programs are available for the desktop, they generally produce files in the 16MB range per tree. I needed a minimum of 18 trees to populate the plaza, along with assorted bushes and hedges. Clearly, botanical, realistic trees were out of the question. What I needed was something that looked realistic, yet was functional on a polygon level.

After several days of experimentation, I settled on a solution that fit the parameters nicely. First, I created a six-sided flat polygon that would serve as a "leaf." Stepping to a second layer, I used the Point Distribution Macro to randomly generate 350 points. Falloff was set so that fewer points were created in the center of the point sphere. Switching back to the layer containing the "leaf," I brought up the point layer in the background, then activated the Point Clone Macro. This clones the "leaf" object and positions the new leaves to match the points in the background layer. To add additional randomness to the cloning process, Jon Tindall, author of the particle animation program "Sparks," modified the macro so that each leaf had a random rotation assigned to it as well as a random scaling that would place smaller leaves toward the top of the tree. I now had a bushy-looking batch of tree leaves. Without the mass of limbs and twigs seen in real-world trees, my tree leaves looked "thin" in the center. To add density to the tree leaves' center, a crude sphere was modeled and sized to fit within the batch of leaves. The sphere's surface was assigned a transparency based on a DPaint map of a similar leaf pattern. This helped provide the proper density while keeping the polygon count low. Adding a tapered tree trunk to the batch of leaves com-

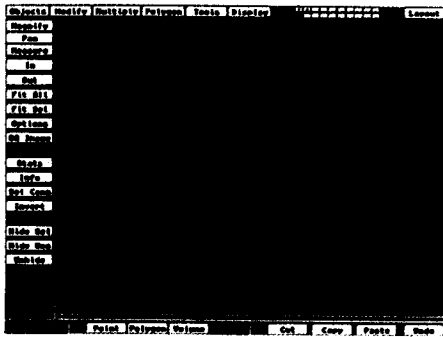


Figure 1

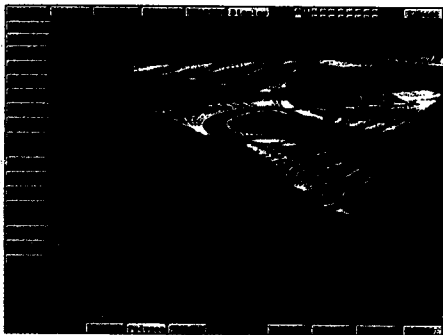


Figure 2

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pleted the illusion. This technique produces trees that look realistic at reasonable distances.

I decided to use a basic box-shape to represent buildings that lined Dealey Plaza's Houston Street. This would keep the polygon count to a minimum, while simultaneously forcing the eye to key on the more detailed building—the Texas School Book Depository.

The Texas School Book Depository

This seven-story, salmon-colored brick warehouse was the building in which accused assassin Lee Harvey Oswald worked and from which shots were allegedly fired. I visited the sixth floor of the Texas School Book Depository in 1983. The Depository had been remodeled to accommodate a number of city offices as well as a new county courtroom. In the process of remodeling, much of the 1963 layout of the building had been destroyed, including the back stairwell that Oswald allegedly ran down after firing the shots. During my 1983 visit, the Dallas County Historical Society was in the process of creating The Sixth Floor, a museum exhibit that has since opened to the public. Although masterfully done, The Sixth Floor exhibit denies viewers the opportunity to look directly out the southeast corner sixth-floor window (it has been glassed in) or descend the back stairwell (it was torn out for the restoration). I was convinced LightWave could unravel some of the mysteries involving the building, so I set out to model a full-scale replica of the 1963 Texas School Book Depository.

Original blueprints for the Book Depository, built in 1901, do not exist. However, a detailed set of blueprints was created in 1978 by Burson, Hendricks and Walls, an architectural firm in Dallas, as a prerequisite to the planned Sixth Floor Exhibit. This set of prints showed the Depository's layout as it existed in 1963.

Floor-by-Floor Construction

Once again, it was necessary to translate the architectural figures into X-Y-Z coordinates. Beginning with the southeast corner base of the book building and working my way around to the west, I used the Enter Points macro to create points that outlined every nook and turn of the outer and inner wall. After connecting the points, the wall shell was turned into a single flat polygon (Figure 3). Using the Extrude function, the base wall was "pulled up" to the height designated by the architectural drawings (Figure 4).

This same procedure was followed to create each floor of the building. Modeler's Boolean function made creating windows simple. There are some minor variations in the size of the windows throughout the Depository, but for the most part I was able to create a single window "cutter," then clone it around the walls before doing one Boolean/Subtract cut per floor.

I found it handy to name the surface of the Boolean cutting object as "cutter." After the Boolean operation, these polygons could be quickly selected (R-Amiga/W) and cut or renamed. I also got in the habit of saving

consecutive subversions of an object (Object_SubA, Object_SubB, etc.) as I progressively modified it, which helped facilitate experimentation without jeopardizing my previous work.

After punching out window sills in the building, each hole was fitted with a fully dimensioned window sash (Figure 5). Each variation of the Depository window sash was modeled directly from Dallas Police Crime Lab photographs obtained from the Texas State Archives. Modeler's Boolean and Beveling tools made this difficult task a breeze. Once created, the sash variants were cloned and positioned into the window sills.

Additional details—window ledges, decorative bricks, corner columns and the rooftop Hertz sign—were modeled based on blueprints and vintage photographs of the building.

Turning to the Depository's interior, I used blueprints to model the northwest corner staircase as well as the floorplans for the first, second and sixth floors.

The Sixth Floor

A significant number of crime lab photos and film footage exist of the infamous sixth floor. I realized that enough photo evidence existed to recreate the arrangement of boxes for the entire floor. Working from photos collected from the National Archives, Texas State Archives and private collectors, I modeled several variations of the boxes seen throughout the sixth floor. The completed boxes were then arranged in large groups within Modeler. This allowed me to load hundreds of boxes into Scene Layout as a

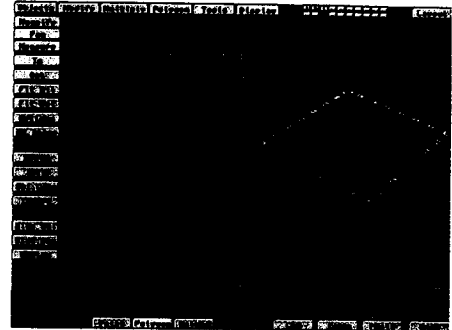


Figure 3

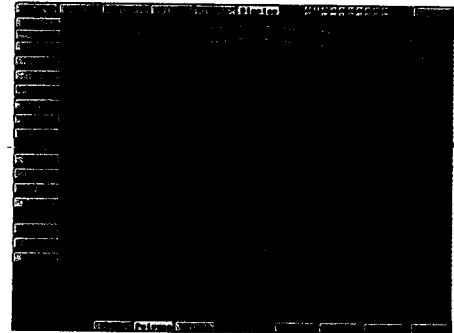


Figure 4

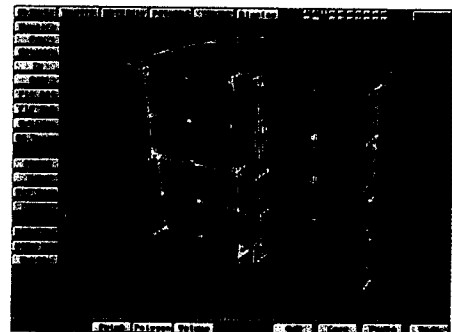


Figure 5

Secrets of a Homicide

single object. In all, more than 5,000 sixth-floor boxes were arranged according to photographs (Figure 6).

The Sniper's Nest

Great care was taken to ensure the positional accuracy of the "sniper's nest"—a barricade of boxes around the southeast corner window of the sixth floor.

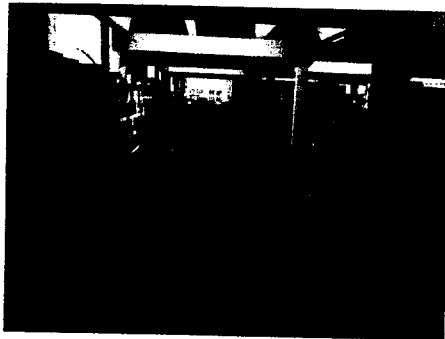


Figure 6



Figure 7



Figure 8

The controversy about the position of these boxes centers around Dallas Police Crime Lab photos and news photos that show the boxes in various configurations.

Past writers have charged that the sniper's nest was an invention of the police in an attempt to frame Oswald. They point to the various box arrangements seen in police photos as proof of the fraudulent evidence. Yet a careful comparison of photos and testimony reveals that the box photos depict a natural progression of the police investigation.

News footage shot by WFAA-TV cameraman Tom Alyea and two Dallas Crime Lab photos show the boxes in their original position. After these photos were exposed, the police photographer was called to the northwest corner of the sixth floor, where the rifle had been discovered. Homicide Captain Will Fritz

wanted pictures of the rifle before it was moved.

In the meantime, Crime Lab investigators had moved the sniper's nest boxes in order to dust them for fingerprints. The police photographer then returned to the sniper's corner and took additional photographs that show the new arrangement. It is clear which pho-

tos were taken after the dusting because you can see dusting powder on the boxes. Afterward, newsmen were allowed to photograph the view from the window for the morning papers, and further arrangements made it into the photographic record.

Matching the Box Photos

Once the photo sequence of the sniper's nest had been sorted out, I proceeded to reconstruct the box arrangement. In the official record I found that the Dallas Police had recorded the width of the floor boards seen in photos of the sniper's nest. Knowing the size of the window sash, I deduced the width of the bricks on the window sill. Using these two figures along with the known sizes of the sniper's nest boxes, I was able to arrange the sniper's nest boxes in Scene Layout with considerable accuracy—within a half-inch.

To confirm that the box arrangement I created was accurate, I decided to render two views of the window from street level that matched photos taken seconds after the last shot. Tom Dillard, a *Dallas Morning News* photographer riding in the eighth car behind the presidential limousine snapped one photo three seconds after the last shot (Figure 7). James Powell, an army intelligence officer, took a second photo approximately 30 seconds later (Figure 8). LightWave's camera was adjusted until a match was achieved between the re-creation and the original photographs.

A comparison of the two original photographs with their computer counterparts confirms that the arrangement of the sniper's nest boxes as seen in Alyea's film footage and the first two Crime Lab photos was the original arrangement. Equally revealing was something I had not anticipated.

Unraveling a Mystery

The 1978 House Select Committee on Assassinations Photographic Panel had compared Dillard and Powell's photographs and concluded that the boxes in the sniper's nest had been moved during the interval between the two photographs. The panel's finding could only mean that the gunman or an accomplice had lingered at the window after the shooting to rearrange the boxes. Oswald was encountered by Dallas police officer Marion Baker on the second floor less than 90 seconds after the shooting. In order for Oswald to have been the gunman, he would have to have left the sniper's nest immediately to get to the second floor in the allotted time. The House Select Committee's conclusion about the boxes being moved provided a photographic alibi for Oswald.

However, the computer re-creation of Dillard and Powell's view of the window shows that the arrangement of the boxes in the window is identical in both photos. I rendered an additional version of the Dillard and Powell perspectives, this time making the outer wall of the Depository semi-transparent and the sixth floor invisible. Comparing these two renderings (Figures 9 and 10) makes it quite clear that the apparent change in the arrangement of the boxes is due to the differing angles at which the photos were taken.

The Presidential Limousine

On November 22, 1963, President Kennedy was riding in a custom-built, 21-foot-long 1961 Lincoln Continental convertible. The actual dimensions of the limousine are readily available, having been part of the official assassination records of both the Warren Commission and the House Select Committee on Assassinations. Rather than build the automobile from scratch, I decided to purchase Viewpoint DataLab's 1963 Lincoln Continental computer model and alter it to match the dimensions of the original assassination vehicle. The model used in the project is therefore a hybrid—the 1963 version pulled, stretched and modified into the dimensions of the 1961 model. Additional cosmetic alterations were done to give the final model the "look" of the 1961 Lincoln.

Regarding the occupants of the limousine, I felt that it was important to avoid doing realistic, physical portrayals of Kennedy and Texas Gov. John B. Connally (JBC). Instead, the goal was to create a more generic-looking "human," which would underscore the project's scientific approach and avoid crossing the line of good taste. I ultimately settled on Crestline Software's Humanoid to provide stand-ins for JFK and JBC.

Preparing the Scene of the Crime

With the limousine and occupant models complete, I was ready to set up the assassination sequence. The most important part of developing something this complex is to create enough rotation controls to cover the circumstances you're going to encounter throughout the sequence. With LightWave, rotation controls are simple Null points (invisible point objects created in Modeler) that are parented to the object to be controlled, with each assigned a single rotational direction. In the case of the limousine, a Path-Null was used to propel the automobile down the roadway, a Y-Axis-Null allowed the car to follow Elm Street as it swept down and under the Triple Underpass, a B-Axis-Null provided roll control as the limo navigated the slight hump in the roadway, and finally, an H-Axis-Null gave me control over the heading of the car as it snaked through the plaza. The position of the occupants of the auto was controlled with two nulls: one that locked them to the limousine and a second that controlled their distance from each other.

The goal was to create an animated sequence that covered the presidential limousine's entire journey through Dealey Plaza, from the corner of Main and Houston to the Triple Underpass. The computer animation would be recorded at 30 frames-per-second (fps), as opposed to Zapruder's 8mm film speed of 18.3 fps. The conversion would require the computer to "expose" 1.639 frames for every frame in the original film. A chart was created listing the numbers of each of Zapruder's 486 frames along with their matching computer counterparts.

A copy of the Zapruder film was transferred to hard disk using the Personal Animation Recorder. The digital anim file was split into individual frames and each was renumbered to match its new "computer" number. This allowed me to go to any frame in Scene Layout

and automatically bring up its matching Zapruder frame as a Background Image.

Rotoscoping the Z-Film

To bring the JFK shooting into a 3D environment, I used a twist on a technique known as rotoscoping. Traditional rotoscoping is the process in which individual frames from a moving sequence are traced, colored or altered in some fashion, then re-compiled into a moving sequence. For *Secrets Of A Homicide*, I matched the motion of my 3D scale model to a 2D film of the actual event. This was accomplished by superimposing selected frames from the Zapruder film over a matching view of the 3D computer world. Key frames were then created of the matching positions of both automobile and occupants.

To begin, I matched the position and speed of the limousine model to the actual automobile seen in the Zapruder film. Lampposts and traffic signs located between Zapruder and the limo provided convenient markers with which to make spline adjustments until a perfect match was achieved. This process revealed that shortly after JFK and JBC emerged from behind the Stemmons Freeway sign, the limousine decelerated up until the headshot. Limousine driver William Greer, who can be seen looking toward the backseat during this sequence, apparently took his foot off the accelerator as the shots struck the president.

With the limousine moving down Elm Street at the proper speed, I began "keying" the motion of the JFK and JBC models to the film. Zapruder frame 139 (Z-139), the first clear frame showing both men, was used to establish their initial positions. Key frames were then periodically created for both men as the film progressed. Because of the computer's ability to interpolate motion between two fixed positions, it was not necessary to create a key at every Zapruder frame. However, to ensure that the motion seen in this 3D version was faithful to the original, key frames were established for every major change in the occupants' motion. In most cases, keys appear every 20

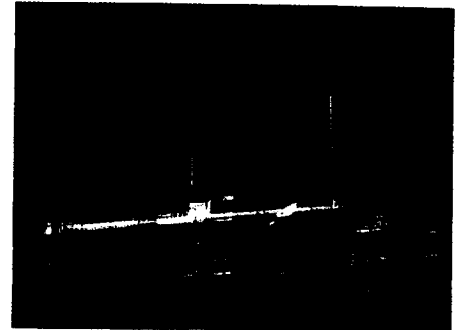


Figure 9

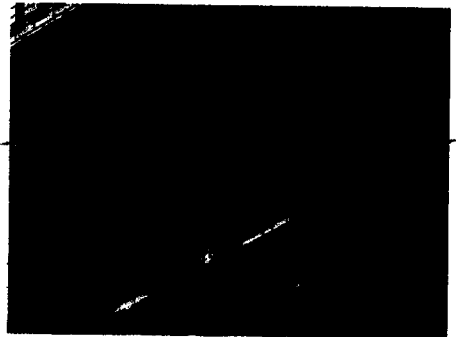


Figure 10

Secrets of a Homicide

frames, though extreme motion areas required key frames at three- to five-frame intervals in order to keep the computer re-creation locked to the Zapruder film.

After completing the 3D roto-scoping process, frames located between key frames were randomly selected and compared to their corresponding Zapruder frames. This "spot check" confirmed that LightWave's interpolation routines were accurately re-creating the motion of the original sequence.

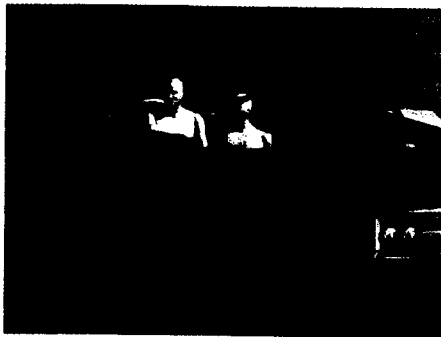


Figure 11

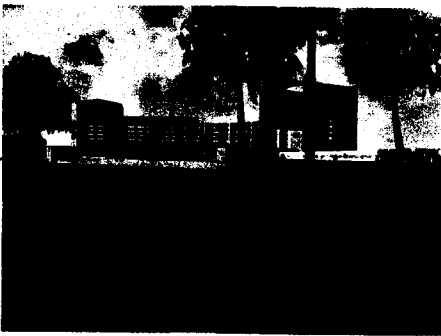


Figure 12

Establishing a Margin of Error

Like all science experiments involving human interaction, it was necessary to establish a margin of error. Due to the photographic quality of the original film (the image size of JFK and JBC on the original film is less than the head of a pin), I found that I could rotate the model's appendages up to five degrees without a significant visual clue.

This figure tends to decrease as the occupants draw closer to Zapruder's camera and the images increase in size and clarity. Al-

though the roto-scoping process is by definition subjective, all key frames are within this 5 degree rotational margin of error. The 1978 House Select Committee on Assassinations used the same figure for similar reasons during its photographic analysis of the Z-Film.

To create the motion of the president and governor between the corner of Main and Houston streets and the start of Zapruder's film, I relied on all available films and stills exposed during this period. Very few gaps exist in the photographic record, so it was possible to gain a reasonable degree of accuracy to this portion of JFK and JBC's motion files. Because the roto-scope process was not used to create this earlier sequence, the motions seen are only representative of JFK and JBC's movements during this period. Still, the computer's ability to interpolate motion between fixed positions has created an eerie sequence leading up to the assassination.

Rendering the Assassination

The final Dealey Plaza model contains more than 250,000 polygons and took four months to complete.

Roto-scoping the Zapruder and other films required an additional two months to create, check and re-check. The time had come to play the role of eyewitness.

The camera used by Zapruder was a handheld 8mm Bell & Howell Zoomatic windup model. FBI tests confirmed its running speed to be 18.3 fps. My intention was to re-photograph the shooting from Zapruder's position as if I had a 35mm motion picture camera running at a speed of 30 fps. LightWave's camera was positioned at Zapruder's location and the focal length adjusted to 285mm. This would provide the closeup view Zapruder was unable to record.

The resulting animation was nothing short of astounding. Nearly 35 years after the shooting, I was able to watch those tragic moments with unparalleled clarity. What the computer captured was very revealing.

The First Shot

As the limousine completes its turn onto Elm Street and begins the glide toward the Triple Underpass (Z-139), JFK and JBC are seen gently brushing their hair back. Both men turn toward the crowd on their left (Z-155 to 160). At that moment, something happens. Both men turn sharply to the right side of the car, JFK just before Connally. The governor's reaction is consistent with his testimony that he was looking left when he heard a gunshot and turned right to see what had happened. If a shot was fired at this point, it apparently missed both the limousine and its occupants.

Although JFK reacts with Connally, his turn appears related to a crowd gathered at the north curb of Elm Street between a lamppost and the R.L.Thornton Freeway sign (Figure 11). This fact was confirmed by locking the computer camera to JFK's facial plane and rendering the sequence. JFK is clearly tracking the area near the lamppost as the limousine passes (Figure 12). A photograph taken by Hugh Betzner Jr. shows a group of women standing at this location smiling as they wave handkerchiefs at the president.

From Zapruder's position, JFK is seen lifting his right forearm off the side of the car as he waves to the women at curbside. The House Select Committee on Assassinations interpreted the blurry images between Z-189 and Z-197 as an indication that JFK had been shot just before he passed behind the Stemmons Freeway sign. It appeared to the photo experts that JFK's right hand "froze" at this point. However, the computer re-creation reveals something else—a sharp, abrupt continuation of JFK's turn to his right. Viewing the sequence from JFK's position, it is clear that the president was tracking the women at curbside. Perhaps someone called out at the last moment. The president turned further right, but was too far past their position. He spun left (Z-195 to Z-204) and resumed his forward-facing posture.

Meanwhile, Gov. Connally was looking to his right, the blurry crowds flashing past just one lane away. From the moment Connally completed the sharp turn to his right (Z-170), he began slowly rotating back to his left until he was hit. This is not as evident in the original film, but does show up in the computer re-creation as a rotation of about 15 degrees. This motion is consistent with the governor's recollection that he was in the process of looking

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over his left shoulder when he was shot. Nearing the Stemmons sign, Connally looks up toward the east end of the north pergola.

The Second Shot

The exact moment JFK and JBC were first hit has been the most venomous subject of debate since that day in Dallas. The 1964 Warren Commission picked the sequence Z-210 to Z-225 (while JFK and JBC were behind the sign) as the point of impact and claimed one bullet struck both, giving birth to the single-bullet theory. During the last 30 years, dozens of theories have been put forth by writers and amateur sleuths countering the Commission's claims. Just about every Zapruder frame from Z-190 to Z-240 has been used to bolster a theory about the first hit.

Part of the problem stems from Zapruder's shaky, hand-held camera work, which makes it difficult to focus attention on a specific area of the frame. Other problems arise when attempting to diagnose moving events from still enlargements. Frozen moments in time can be easily misinterpreted without the elements of time and space. By far the biggest problem with viewing the Zapruder film is the Stemmons Freeway sign, which comes between the presidential limousine and the viewer at the crucial moment.

Still frames clearly show the president grimacing as he emerges from behind the sign (Z-225). The question remaining is how much earlier was he hit and whether Connally shows a reaction to being hit at the same time.

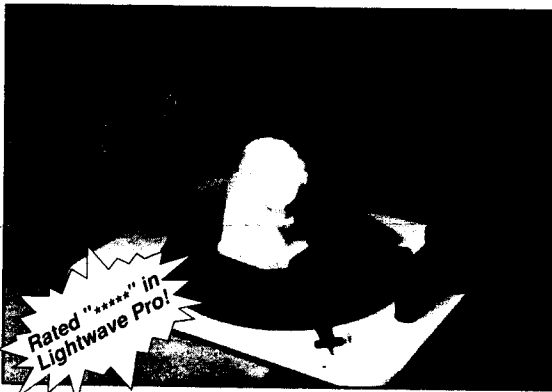
Watching the Z-Film in motion hoping to catch this subtle clue is an effort in frustration. It takes the human eye approximately five to 10 frames to recognize shapes in motion. By the time your eye locks on JFK and JBC, the film has already progressed to Z-230 to Z-235, where both are already reacting.

The 3D computer model of the JFK assassination effectively eliminated these technical limitations. Now, the computer camera followed the action with an ultra-smooth pan, image sampling was nearly doubled from Zapruder's original 18.3 fps to 30 fps, and the obtrusive Stemmons Freeway sign was assigned an 80 percent transparency value. The action behind the sign was interpolated by the computer based on the first and last frames in which JFK and JBC are visible. What happened behind the sign is no longer a mystery.

Mystery Behind the Sign

As Kennedy completes his left turn away from the women at curbside and Connally gazes up at the north pergola (Z-204), the limousine passes behind the freeway sign. JFK's right arm begins to resume a position he's kept throughout the motorcade—right arm on the side of the limousine, left hand up, holding his right fingers across his chest. The president's head tilts back slightly so that he's looking almost directly at Zapruder. Perhaps he glimpsed the Dallas dressmaker standing on the four-foot-high pedestal just as he slipped behind the sign.

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Secrets of a Homicide

As Connally emerges from behind the sign (Z-223), the computer captures the moment of impact. From Z-223 to Z-227 (approximately one-quarter second), the governor's chest is driven downward nearly two inches, while pivoting violently to the left. At the same time, JBC's right arm flips upward, then down and out of sight as the governor spins to his right

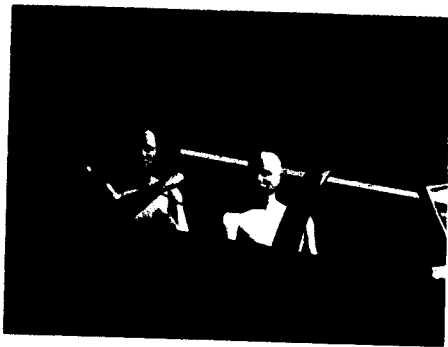


Figure 13.



Figure 14

This fact, combined with the motions seen in the 3D computer re-creation, would seem to confirm a hit to the governor's chest at approximately Z-223.

A Single Bullet?

The question haunting conspiracy-minded researchers is whether that same bullet hit JFK and from what source. For more than 30 years, scholars and researchers have argued over the location of JFK's back and neck wounds. Was it one bullet clean through or did two bullets strike—one from the front, the other from behind—and at what angle? The House Select Committee on Assassinations used the locations—still contested—of both men's wounds as presented by its expert medical panel. Connecting Connally's chest inshoot wound with JFK's throat outshoot wound, they created a line in space that was then extended back to the alleged source. Considering that JFK's wounds are still a subject of much debate, I decided to approach the answer through the location of the only wounds most researchers agree on—those in the chest of Gov. Connally.

Turning to LightWave Modeler, I set about to find the

definitive answer. I loaded the "chest" object from the Humanoid models into the first layer. A point was created at the X-Y-Z zero point (0,0,0) in a second layer. This point and a clone were then moved to the positions that represented the inshoot and outshoot chest wounds of the governor as determined by the House Select Committee on Assassinations. The two points were then joined into a single-line polygon, and the line was extended rearward 200 yards. This line now represented the path of the bullet that passed through JBC's chest.

Returning to Scene Layout, the bullet track was loaded and parented to Connally's chest, retaining the relationship created in Modeler. Now, as the governor rotated in the jump seat, the bullet track would point to a source location. I rendered the computer frame that matched Z-223 and studied the resulting image (Figure 13).

Moving rearward from JBC's chest wounds, the bullet track encounters JFK's throat at precisely the point seen in the autopsy photos. Continuing rearward, the line intersects Kennedy's back near the shoulder line. Moving further rearward, the bullet track enters the southeast corner window of the sixth floor of the Texas School Book Depository.

This initial discovery was then subjected to the five-degree rotational margin of error inherent in this technical approach. This error can be represented by a cone that is spread to a radius of 22.5 feet as it meets the south face of the Depository. The trajectory of the shot that struck Connally must fall within the area defined by the cone.

Rendering Z-223 with the "error cone" in place provided the answer to the single-bullet question (Figure 14). If Connally was hit at Z-223, then it's almost a certainty that the same shot struck JFK first and came from the sniper's nest window of the Book Depository—the only open window unaccounted for within the cone.

The Head Shot

Both men react within four frames of being hit. JFK slumps to the left, elbows up, while Connally wheels to his right and into his wife's arms. At the moment of the head shot (Z-313), the president's head slams forward nearly two inches, then reverses into a recoil against the backseat (Z-319).

Determining the trajectory of the shot to JFK's skull proved to be more elusive. The House Select Committee had calculated a trajectory that intersected the south face of the Depository 15 feet above the sixth-floor window sill. This was based on a straight line drawn between the inshoot and outshoot wounds evident in X-rays and assumes the bullet did not change course as it passed through JFK's skull. This assumption is challenged by additional evidence that the bullet fragmented on impact, leaving two large chunks on the floor of the limousine as well as a trail of minute fragments in the president's brain. There was also damage to the limousine's windshield and a chrome strip above the sun visor.

To check the committee's work, I entered Modeler and created a bullet track trajectory matching the line it had used. The line was extended rearward 300 yards. Returning to Scene Layout, the bullet track was parented to the president's head and several viewpoints were rendered.

Based on the three-dimensional positioning of JFK's skull in frame 312, the House Select Committee's trajectory line was shown to intersect the south face of the Depository 60 feet above the sixth-floor window sill—not 15 feet as reported by the Committee. After including a 27.5-foot radial margin of error, it was clear that it would be impossible to fire a bullet along this line from the Depository or any other adjacent buildings. These results indicate that the House Select Committee's positioning of JFK's skull at Z-312 was incorrect. It also bolsters the notion that the bullet changed course before exiting the skull which, by definition, would eliminate the ability to calculate any true trajectory based on the inshoot and outshoot wounds to the president's skull.

Entertaining the hypothetical, I calculated a line from the sniper's nest window to the president's head at Z-312 and then extended that line forward. This line exits the top-right-rear of JFK's skull—within the area blown out upon impact. Although this should not be construed as a true headshot trajectory, it does demonstrate that the damage to JFK's skull is consistent with a shot from the Texas School Book Depository.

Shot From the Grassy Knoll

Preliminary work on a theoretical shot from the grassy knoll to JFK's head between Z-313 and Z-314 reveals a number of interesting facts. First, the president's body trav-

els straight back toward the backseat cushion, not to the left, as a shot from the grassy knoll would dictate given its location nearly 90 degrees perpendicular to JFK's head. Second, a cone representing a shot entering any portion of the displaced skull and exiting the lower-right-rear area (as suggested by numerous researchers) virtually eliminates a shot at Z-313 from any location to the right of the midline of the limousine. Such a shot would have to come from the south plaza knoll, not the north plaza grassy knoll as has been suggested.

A Full Exploration

Computer imagery involving Oswald's encounter with Officer Baker on the second floor of the Texas School Book Depository and other key areas of the JFK assassination is currently being rendered for the final program, scheduled for completion in spring 1995. A national broadcast of this photorealistic computer documentary is anticipated.

Secrets of a Homicide is sure to add fuel to the assassination controversy as history confronts science in three dimensions. This time, you will be there.

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