



Research Article

ANALYSIS INTEGRITY OF THE PATTERSON-GIMLIN FILM IMAGE

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ABSTRACT. The Patterson-Gimlin Film (PGF), which depicts a walking figure suggestive of a cryptid hominoid species known as sasquatch (or Bigfoot), has been studied and debated since its filming in 1967. One issue not analyzed conclusively is the suspicion that the film itself has been somehow tampered with or otherwise edited to hide data that may point to a hoax. The integrity and quality of the film image have also been challenged and characterized as unreliable. A comprehensive study of these issues of contention has determined that the film was not altered or otherwise tampered with for deceptive intent, and that the image quality is sufficient for factual analysis of the nature of the subject as depicted.

KEY WORDS: Bigfoot, sasquatch, Bluff Creek, cinematography, photogrammetry

INTRODUCTION

Null Hypothesis: The original Patterson-Gimlin Film (PGF) has either been altered, or its image quality is insufficient for analysis, or both, invalidating its evidentiary reliability for conclusively determining whether it depicts a real and novel biological entity.

Alternate Hypothesis: The original PGF film was not edited or tampered with prior to copying, and its image quality is sufficient for reliable analysis and determination of the nature of the subject.

A number of points of contention have arisen in ascertaining the integrity of the PGF as evidence. The following questions must be addressed and determinations made before proceeding with further analysis of the film and its subject:

1. Has the film been edited?

2. What is the resolution of the camera original film stock and what level of image detail can be relied upon?
3. If copies are studied in the absence of the camera original, how were the copies made and how does the copy process alter the film image data?
4. Is the film in focus?
5. Is there motion blur, from either motions of the camera or motions of the subject being filmed?
6. Are there sufficient varying camera angles to allow an accurate and reliable three-dimensional reconstruction of the filmed event?
7. Can the camera positions be determined with factual certainty in relation to the landscape?
8. Can the walk path of the filmed subject be determined with factual certainty in relation to the landscape?

9. Can the position of the filmed subject be determined in relationship to the camera position?
10. Can copy artifacts and physical impacts and alterations of the film material (such as scratches, water stains, and dust or lint particles on the film) be accounted for?
11. Are there any other ways the film image data could be tampered with?

DEFINITIONS

A glossary of terms used in this document is provided:

Splice - To join two pieces of motion picture film together by use of a clear adhesive tape or glue.

Edit - To add, delete, or re-arrange the order of motion picture film segments.

Perforation (aka *Sprocket Hole*) - the rectangular holes along one or both sides of a motion picture film stock to allow the projection and printing mechanisms to control the movement of the film stock through the mechanism.

Single Perf - A film stock with perforations on only one side of the film stock, usually to allow an audio track to occupy the opposite side outside the central picture area.

Double Perf - A film stock with perforations on both sides of a film stock and thus no allowance for an audio track.

Camera original - The actual film stock run through a camera and capturing some type of filmed images.

Printing Original - The film stock with image data on it supplied to be copied. This is not necessarily a camera original. It is whatever film is supplied for copying.

Copy Stock - the raw (unexposed) film to be copied onto.

Copy - A duplicate of a printing original film.

Contact Print - A 1:1 copy process where the copy has the same number of image frames and the same image size as the source film (printing original).

Optical Print - Made on a device called an Optical Printer, the device is a projector coupled to a camera, and this device allows for various ways for a printing to occur, because the lens on the projector can project the source image to the camera at a 1:1 size ratio, or zoom in and magnify the copy image to larger than the source, the projector and camera can operate at different frame rates, to produce copies in slow motion or fast speeds, and other optical effects combining multiple source film segments onto the copy (crossfades, image composites, etc.)

Leader - Film stock which may be clear, opaque white or opaque black, and is generally used at the head and tail of a film roll or sequence. It allows for setup on a lab film processing machine, projector or printer before any actual picture segments are in the film gate for viewing, as well as for physical writings or markings to identify the film without marking the picture area.

RESULTS AND DISCUSSION

The responses to the foregoing points of contention, based on extensive examination of archived scans of all available copies of the PGF, are hereafter provided, discussed, and the contended issues conclusively resolved.

1. Has the film been edited?

This question is one that goes to the heart of the issue of evidence integrity. Is what we see what actually occurred? On a camera original, evidence of editing is obvious because the physical cuts and reassembling of film segments cannot be hidden from inspection. However, with Roger Patterson's death in January, 1972 (less than 5 years after the event), and the camera original at that time in the possession of a film production company, American National Enterprises (ANE) the

family trauma of his passing took all attention away from the question of reclaiming the camera original film. The ANE maintained possession of the camera original. The subsequent bankruptcy of ANE caused the film to be inadvertently acquired by another party in a bankruptcy liquidation sale of the assets of ANE. The new owner placed the film with a film storage service in Los Angeles, but in 1980, researcher Rene Dahinden convinced the film storage staff that he had rights to the film and thus had authority to check it out for further examination. There is no record of the film being returned, and so it is classified as missing, whereabouts unknown, at this time. However, before the original was lost, many copies were made and a systematic analysis of these varied copies and the processes used allows us to determine the condition of the original.

To understand how a question of splicing of the camera original can be analyzed from copies, it is incumbent to first understand the splicing process. What is commonly referred to as “splicing” is physically joining two separate pieces of film so they will run continuously through a projector or laboratory printer. “Editing” is the general practice of making physical cuts in a film, to separate the desired footage from unwanted footage (called “outtakes”), and then assembling the desired footage in a chosen sequence, by a given splicing technique. One may splice without editing, as in the example of using 50’ magazine loads of film, and once they are processed, the lab may splice several such 50’ segments together onto a larger reel so they may be projected and viewed continuously, as if being one longer segment. But editing does require splicing to assemble the edited segments.

The common editing process is a rather simple mechanical process requiring the following steps:

1. Cut the end of the first segment of film (which may be the actual end of the

segment or before the end).

2. Cut the start point of the second segment of film (cut at the point in this segment the editor chooses to begin, and not necessarily the first frame of the segment).
3. Join the two together by either adhesive splicing tape or glue.

The way the film is physically cut has several options. The most common is a straight horizontal cut between frames, so the cut does not appear in picture area (Fig. 1).

A second type of cut is usually done in film labs, and it is a tab cut where the line is not straight but rather has a curved notch (the tab), which goes into the picture area of one of the adjacent frames. This tends to be reserved for splicing leader or other film stock which doesn’t have critical frame image data, or no image at all. Head leader, tail leader, and timing countdown footage may be spliced with this tab configuration, but rarely any usable image segments.

A third type of cut is an overlap cut, so one piece of film overlaps the previous piece, and provides a surface for gluing the two pieces together, or hot splicing them.

A fourth option is a diagonal cut, but this is uncommon for segments with pictures because the cut goes through the picture of both segments being joined and may show on projection and viewing. The diagonal cut is actually intended to cut audio magnetic film or tape stock¹ because a true horizontal cut tends to produce an audible “pop” at the edit, while a diagonal cut does not. (Appendix 1. cites multiple sources for this phenomenon). So a 16mm film splicer device with a diagonal blade was likely made to cut 16mm magnetic coated film stock used for an audio soundtrack, not photographic imagery. In examining archival film, the authors have found examples of this diagonal cut used on

¹An example of magnetic coated film is Kodak Magnetic Sound Recording Film, A704, as described in the ASC Manual, p. 264.

picture segments, but it is uncommon in practice.

Once the film segments are cut, they must be joined together. The two common options are a splicing adhesive tape, and a film splicing glue or hot splice (Fig. 2). The splicing tape allows the two pieces of film as cut to be butted against each other, so the resulting film is as flat as uncut film. The glue splice requires that one piece of film be cut into the image frame area and the other cut on the frame separation line, so there is a physical overlap, and the glue is applied to this physical overlap, like shingles on a roof. One must also scrape the emulsion (containing the image data) from one of the film parts that has the overlap, so there are not two pictures from two emulsion layers. Churchill (1971) describes the options and their relative advantages and disadvantages in detail (see Appendix 2)

When a 1:1 copy is made by contact printing (i.e., the copy image is the same physical size as the source image), a glue splice will always show on the copy for 16mm film. On an optically printed zoom in copy, it may not, as the zoom in may use only image area closer to center excluding the glue line.

The tape splice has several options as to tape format. Kodak's standard splicing tape for consumer use and some professional use is a tape pre-cut to slightly more than the distance of two film frames. Thus it fully covers one frame on each side of the cut, but continues on beyond the sprocket hole so the tape edge is a smooth horizontal line across the film, and it positions that line in the picture area. Some editors apply a piece of tape to each side of the splice, so there are actually two tape lines in picture area on each side of the splice. The Kodak Splice tape package contains two tape pieces, intended for taping both sides of the physical film. These tape lines will show on a 1:1 film copy, and the splice will be obvious.

An alternate tape splicing technique is to

use a tape which is precisely the height of two film frames (0.6in wide, each frame being 0.3in high) and the tape has its edge lines on the frame separation line so the tape edge is not in picture area. The tape is generally transparent and is often referred to as an "invisible splice" because the process does not put anything visible into the picture area.

Whether or not this splice actually is "invisible" depends on the film lab copy technique. A contact print is a simple mechanical method of running the source film and the copy raw stock physically pressed against each other and a printing light is shined through the source film to the copy stock as the two pieces of film run continuously through the printer (Hall, 1971, p. 141). It prints both the images and the frame separation lines alike onto the copy. So if there is a physical cut in the cellulose film base where the two film pieces are joined, that physical cut will invariably print some light through the cut onto the copy (Fig. 3). Thus, the splice is not invisible on inspection of the physical copy, but since the projector crops the image area slightly and thus doesn't project the frame line between images, the splice would be invisible on projection of the film.

It is essentially impossible to hide the cut line print-through, so no splice would be truly invisible. If the copy is made on an optical printer, however, the optical printer has a projector aimed at a camera, and the copy camera side has its own aperture window, so a cut in the source film cellulose base at the frame separation line may not show on the copy film stock (Hall, 1971, p. 149). Under those circumstances, the splice cut line would not be seen on the copy.

The PGF has been copied several times and by several methods, but the first set of copies made for Roger Patterson himself in 1967 (herein referred to as the PAC Group) were 1:1 contact prints and so any splice where the cellulose base is cut would print through a cut

line onto those copies. The author has examined every frame of several true contact prints, and there is no cut line anywhere in the contact print copy. This would be the single most conclusive indicator if the PGF camera original had been spliced before copying, and the indicator is absent. Therefore, it is conclusive that the original film had not been spliced before copying.

There are additional factors in evaluating the prospect that a film has been edited:

1. Absence of camera starts would be an indicator that the segment has been trimmed and early frames were deleted. PGF camera starts are intact. This factor does not support an argument for editing.
2. Lack of continuity of position of subject or camera would be an indicator of footage rearrangement, i.e. editing. However, continuity of the paths and positions of both film subject and camera operator are consistent with the event occurring as shown. This factor does not support any argument of editing.
3. Lack of continuity of shadows would indicate passages of time greater than the time the event is described to have occurred (within a minute or two in total), but there is no lack of continuity in the footage which would support any argument for film segments taken at different times with interruptions between in order to plan or choreograph the next filming segment before filming it. So there is no support for any argument of editing segments taken at different times of the day.
4. The light washout along the edge of the film is consistent with the last segment of a 100ft daylight load reel, and the subsequent unloading under low light (but not true darkroom blackness), indicating the PGF was the last segment of the 100ft roll. Copies of the entire first reel content, with the PGF as the last segment, account for almost 100ft and thus tend to support the entire content of the reel as described. No

irregularities have been found to suggest the described and scanned complete first reel is edited.

Thus, aside from the lack of print through of physical cut lines on any contact print of the PGF, the four points above further substantiate that there is no evidence that the PGF original was edited in any way before it was copied. Thus the known and studied copies are a true and reliable frame-by-frame duplication of the camera original. These copies can be studied with the same confidence as if we were studying the camera original.

A point of confusion for those lacking knowledge of film editing is the fact that many copies have been made of this film, and some of those copies were in fact edited for specific television programs. As such, splices can be found on those programs, if one examines the program frame by frame (Fig. 4). Those determined to claim the PGF is edited, and therefore a hoax, have seen some of these program edits and splices and mistakenly claimed these as proof of the original being spliced. What they fail to realize is that modifications of editing and splicing of a copy does not alter the integrity of the original. Only if an edit and splice can be found on the same frame of every copy can there be any real suspicion of the edit and splice being present on the original.

2. What is the resolution of the camera original film stock and what level of image detail can be relied upon?

There is some confusion in various references pertaining to the measured resolution of Kodachrome II film. The resolution standard is described as "Lines per Millimeter" (or lines/mm). *Popular Photography Magazine*, in a lengthy series of articles reviewing the introduction of Kodachrome II film, states that Kodachrome II film has a resolution of 56 lines/mm (Drukker 1961).

Fahrenbach (1999)² states that Kodachrome II film has a resolution of 63 lines/mm. He then divides this number by 2 in order to determine “Line Pairs per Milimeter” at 31.5 line-pairs/mm. However, photography expert James K. Beard³ states, “The truth of the matter is that none of the color films exceeds about 65 line pairs per millimeter. Kodachrome, while it lasts, is a little better because the emulsion is thinner than that of any E6 or C41 process film.” Thus, he is describing Kodachrome II film as having twice the resolution that Fahrenbach describes and the *Popular Photography* expert staff lists.

From Wikipedia we find the statement: “Photographic lens and film resolution are most often quoted in line pairs per millimeter.”⁴

So there appears to be a situation here where people may write “lines/mm” and actually mean “line-pairs/mm.” To resolve this discrepancy, a physical examination of the sharpest and most highly detailed frame copy from the PGF is needed. This image is a 4x5in color transparency made by Kodak labs for Roger Patterson in 1967. Given this transparency is so much larger than the source original, the film grain of the transparency was sufficient to actually copy perfectly the grain pattern of the camera original, and thus may be considered of equal detail as the Kodachrome II camera original. It is the current benchmark of image quality for all PGF image references (Fig. 5A).

This transparency has been scanned twice. The first scan was done by Mr. Marlon Davis (date unknown) and he posted a 5K (5028x3549 pixels) scan image on the internet for people to download. The second scan was done by Munns, at a higher resolution (7656x5245 pixels) by scanning sections at

4272x2848 and assembling the scans into a single complete image.

The American Society of Cinematography (ASC) manual, compiled and edited by Joseph V. Mascelli, provides physical standard specifications for 16mm film, and lists dimension from bottom of one perforation to the next (labeled measurement “B”) as 0.3000in for long perf film, and 0.2994in for short perf film. According to www.cinematographyforum.com, Kodachrome films were long pitch (0.3000in) so we will calculate for long perf 0.3000in (and if the film is short perf, the margin of error is 0.2% (1/5th of 1%) (see p. 287).

Long perf film is 0.3in high for one frame plus the black frame dividing line, and this PGF Transparency has been cropped to exactly one image frame plus one black dividing line thickness (although as pictured, half that one black frame line is above and half is below the image). Study sections will be enlarged by a factor of two for more accuracy in comparing resolution lines, so the enlarged study areas will be from an original at 10,490 pixels high (twice the 5245 pixels high). This 10,490 pixels high equals 0.3000 in or 7.62mm.

If the resolution as stated by Fahrenbach is 63 lines/mm, the finest detail in this image should be a line 21.85 pixels (rounded to 22 pixels since Photoshop cannot display fractions of one pixel). Thus, by the Fahrenbach calculation we should not see any clear horizontal line below 22 pixels in height [calculation is $(10,490/63)/7.62 = 21.85$].

According to the *Popular Photography Magazine*, Kodachrome II film stock has a resolution of 56 lines/mm. Therefore, the film should not resolve any line object finer than 24.58 pixels high (rounded to 25 pixels).

According to Beard, Kodachrome can resolve at least 65 line-pairs/mm or 130 lines/mm. Therefore, the film should resolve a horizontal line object at 10.589 pixels (rounded to 11 pixels) (Fig. 6).

²<http://www.bigfootencounters.com/biology/fahrenbach.htm>

³http://jameskbeard.com/Photography/Film_Pixels.html

⁴ http://en.wikipedia.org/wiki/Image_resolution

Analysis of fine white branches of trees against very dark backgrounds provides good lines to appraise resolution of this film image. One of these branches is clearly defined and is about 11 pixels wide (Fig. 5B). This would tend to support the appraisal by authority James K. Beard, that the lines of resolution are in fact at or near 65 line-pairs/mm and that the *Popular Photography* source may have used the phrase “lines/mm” to mean “line-pairs/mm. This would also suggest that Fahrenbach is incorrect because he specifically describes “lines/mm” and then divides by two to get “line-pairs/mm”.

But even film analysis professionals do acknowledge that “sharpness” is somewhat subjective. Drukker (1961) states, “One of the advances claimed for the new film is sharpness. This is something we found very difficult to verify. The appearance of sharpness is extremely subjective.”

Considering that a 16mm film image can resolve a branch at about 11 pixels from a source full frame image 10,490 pixels high and the PGF Hominid is at the lookback frame about 1/6th of the frame height, she would be about 1748 pixels high in that source image. Dividing that by the determined 11 pixel lines as the smallest detail, that would mean the film can resolve 158.94 lines for her full height.

Arbitrarily assigning an example height of 6ft 6in (78in), the film would resolve a theoretical approximate 0.5in object on her body. Motion blur and lens influence slightly reduce resolution, putting the resolution of the PGF Hominid body aspects at somewhere between 0.5in and 1.0in. To calculate with greater accuracy would require extensive error analysis. For this discussion, the resolving accuracy is left as an approximation in the above range. Suffice it to say, a different determination of PGF Hominid height would affect the resolving dimension accordingly.

It can be concluded that the film resolution is excellent for a 16mm film stock, and image

data taken from it for analysis has a very high degree of evidentiary integrity as a result, as long as we work within the resolution constraints described.

3. How were copies of the camera original made and how does the copy process alter the original film image data?

To begin, there are 5 known instances when the camera original of the PGF was copied. Accordingly, assemblages of copies are included in groups that can trace their “genealogy” back to each time the original went to the lab for copying, and each time by a distinct printing process. Within each group, there can be several generations. These copy groups are:

1. **PAC Group.** Roger Patterson himself sent the original film to a lab for full-frame contact prints in 1967. The Munns PGF database has complete scans of three copies, and partial scans of two other copies of this group.
2. **Transparencies Group.** Patterson had Kodak labs make 4x5in transparency enlargements from selected frames (5 are known, and currently in the possession of Mrs. Patricia Patterson, Roger’s widow). All five known frames have been examined and scanned by Munns.
3. **Green Group.** John Green and Rene Dahinden negotiated with Patterson for Canadian rights to show the film and were given the camera original so Canawest Labs could make copies. The lab made multiple copies in various formats (full-frame at real time, zoom-in real time, slow-motion, freeze-frame, etc.) on an optical printer. They printed to an Ektachrome master, and then struck multiple show prints from that Ektachrome master (Hunter & Dahinden, 1973). Munns has personally scanned all or parts of five different copies from this group.
4. **ANE Group.** In 1970-71, Patterson made

a deal with American National Enterprises (ANE) to produce a feature documentary, titled "Bigfoot: Man or Beast," released in 1971. It included a considerable amount of the PGF. The camera original was loaned to this company so their labs could make copies for the production edit. They used a liquid gate optical printer (aka "Wet Printing" – see Schmit, 1971) a process superior to the one used by Canawest lab services, because even though these were among the last copies made, they have the least scratches. The scratches occurred when Roger projected the camera original many times during the first few months after filming. The liquid gate process is excellent for removal of cel scratches (scratches on the cellulose base side; there is no process to correct for scratches on the emulsion side). These copies, used for the film production, are among the best available. Munns has obtained two 16mm copies for his archives and personally scanned each in its entirety.

5. **Cibachrome Group.** The camera original was stored in a film storage vault, placed there by the persons who inadvertently purchased the film along with other office property in the ANE bankruptcy sale. Sometime between 1978 and 1980, Rene Dahinden was able to borrow the film. He and Bruce Bonney then did some analysis of the camera original and Bonney made 12 high-quality frame copies by a Cibachrome photographic process. Reportedly both paper prints and transparencies were made. These have been scanned by Chris Murphy and Rick Noll at different times. They are, in general, excellent images of the PGF Hominid. The Munns image database has high resolution scans of both the Murphy and Noll scans of the Cibachromes.

While it is possible other copies may have been made, these are the five documented

copy groups the authors can personally verify exist, and can identify specific copies as belonging to which group.

Each group has evidentiary value, in appraising the quality of both copies and the source camera original. For example, it is the Transparency Group which shows the intact Kodak K-100 camera identification notch in full form, and thus this group conclusively proves what kind of camera was used -- Kodak 16mm model K-100 camera. The PAC Group, being true contact printed full-frame copies, proves there was no editing of the original when the copies were made. The 4x zoom-in copies made by ANE are the best for study of the PGF Hominid during the lookback sequence of the film. The 2x zoom-in copies of the Green group are the best for early sequence studies.

But it is also the combined analysis potential of them all that provides the basis to determine what was, and what was not, on the camera original. Something on the camera original would be transferred to all copies. If not present on all, it is a copy artifact and not camera original content.

Another form of evidentiary appraisal of copy quality is copy generation and copy magnification. Both affect the quality of a copy. Copying is a method which is considered "lossy" in the sense that some image detail is lost with each generation, unlike digital imagery today, which is lossless in copying because it is actually just numeric digital code. Film has an emulsion layer which is composed of silver halide particles, which are light sensitive, and exposure to light produces the image. These particles are randomly distributed, unlike a pixel order on a digital image, where each pixel has a specific address and a copied pixel has the same address, i.e., the same location in the image. The random dispersion of the film grain particles means when a copy is made, the film grain of the copy film stock does not exactly align point-for-point with the film

grain of the source film stock. There is no exact source-grain to copy-grain continuity. The random misalignment of grain from one film stock to another slightly diffuses the original sharpness of the source film image. Each subsequent copy generation diffuses the image detail further with loss of sharpness and detail. Any analysis must factor in the copy generation of a film image. To do so correctly, any given copy must be compared to other copies to appraise the copy generation level.

Another very important but much overlooked factor in copy quality is the effect of copy magnification from the camera original. With copies made at a 1:1 size ratio, the grain misalignment quickly makes each copy generation degrade noticeably. If the camera original is set up on an optical printer and the projector lens zooms in to magnify a portion of the source frame into the full copy frame, the image detail to film grain size-ratio changes and the resulting copy is closer to the original in quality and subsequent copies degrade less with each copy generation.

If for example, a 2x zoom-in magnification is made, the portion of the source image that copies is now twice as large as before, making the copy film stock relatively four times as fine a grain for the image content (for one source film grain, there are two copy grains wide x two copy grains high, thus a total of four grains to the source one). If a 4x zoom-in magnification copy is made, the copy film stock is relatively sixteen times as fine a grain as the source image was (four wide x four high). The increasing fine grain in relation to the original image insures far less detail is lost and so these 2x and 4x copy versions are among the best for analysis of the PGF Hominid. Unfortunately, the 4x copies made in the Green Group appear to be slightly out of focus (an error in the optical printer setup), but the ANE Group 4x copies are remarkably sharp, so they are generally the best 4x copies for study.

While copy generation, in general

principle, causes degraded copies of lesser image quality and usable image evidence, the 2x and 4x enlarged copies are important in that the magnification reduces and almost nullifies loss of copy detail.

This methodology of comparing copies over the five copy groups is essential to the most accurate and reliable analysis of the film and its subject.

4. Is the film in focus?

An “in focus” film image is sharp and shows fine detail. A film image which is “out of focus” is fuzzy and lacks detail, often to the extent that objects cannot even be positively identified.

The degree of focus is determined entirely by the lens on the camera. But there is a common misunderstanding that assumes the degree of focus is global, that it is equal across the entire frame image. That is not so. A filmed image may be perfectly in focus for a close foreground object, and totally out of focus for distant objects, or a filmed image may be totally out of focus for close objects and perfectly sharp for distant objects, or a film may have middle objects in sharp focus and both very close and very distant objects blurred (Fig. 7). The optical principle at play here is what is generally referred to as “Depth of Field” (ASC Manual, pp. 185-187). Depth of Field is the near to far range of distance from the lens which is in clear or acceptable focus. Three factors influence how large or small this range is.

The primary factor is the diameter of the lens opening that lets light pass through the lens, a setting commonly referred to as the “F-Stop” setting. The F-Stop number is an inverse comparison of the lens focal length and the diameter of the opening or aperture (ASC Manual, p. 174). So F4.0 indicates the diameter of the opening is 1/4th of the lens focal length. F8.0 indicates the diameter of the opening is 1/8th of the focal length. The lens

depth of field increases in near-far range as the F-Stop number increases, so the near-far range is much greater at F8.0 than it is at F4.0. Any lens which is “wide open” (set at the smallest F-Stop number the lens is capable of) will have the smallest depth of field, and when set at the largest F-Stop number, the depth of field will be the largest range near-to-far.⁵

The second factor influencing degree of sharp focus is the focus ring setting, if the lens has one. The Kodak K-100 standard lens, a 25mm F1.9 Cine Ektar lens, has a focus ring with settings from infinity to 14 in. The Kodak Model “E” camera has a standard lens which is a 20mm F3.5 Anastigmatic lens which does not have a focusing ring, and is classified as a “fixed focus” lens.

The designing principle for the fixed focus lens is that using a film like Kodachrome II, outdoors in clear sunlight, the F-Stop will likely be set at about F8 to F11 and everything from a few feet away to infinity will be in clear focus, because of the very large depth of field. Hence no need to focus.

The designing principle for the 25mm F1.9 Cine Ektar lens is that the F1.9 allows for lower light filming (including indoors) and the low F-Stop number means a shorter depth of field, so a focusing ring allows the user to focus on the most important object in the scene according to the distance that object is from the camera. Other closer or further things may be slightly out of focus, but the essential object is in focus.

The third factor is lens focal length, and a short lens focal length (relatively wide angle lens) has greater depth of field for any given

F-Stop and focus ring setting than a longer focal length (telephoto) lens. Example: A 25mm lens on a 16mm camera, set at F8, and focused on 6ft, has a near/far focal range of 3ft 10in to 14ft 3in (a range of 10ft 5in). A 50mm lens set at F8 and focused on 6ft has a near/far range of 5ft 3in to 7ft 0in (a range of 1ft 9in) (ASC Manual, pp. 199 and 201).

But given that Roger Patterson used Kodachrome II film and he was filming the PGF outdoors in bright sunlight, the non-focusing 20mm set at about F8 (appropriate for the film type and the sunlight condition) would have given him an image that was fully in focus from the nearest objects to the furthest. That is evident in the best image copies from the camera original. Using the 25mm Cine Ektar lens set at F8, the lens could capture everything from 5ft to infinity in perfect focus (if the lens were set at a focus of 10ft). (ASC Manual, p. 199).⁶

The finest image example known from the PGF camera original is a 4x5in transparency made by Kodak labs for Roger Patterson of Frame VFC-352 (which is actually Verified Frame Count VFC-354)⁷. Mrs. Patterson currently possesses this transparency. Munns has personally scanned this transparency at a resolution of 7656 x 5245 pixels. It is the benchmark image for PGF image quality and it is in perfect focus from the closest object (about 10ft away from camera) to the farthest

⁵ A “T-Stop” is also on some lenses. This is a calculation that considers how much light is lost passing through the lens elements and thus adjusts the F-Stop accordingly. It is used to ensure the exposure setting is for the true amount of light actually passing through the lens, not just the mechanical ratio of lens aperture to lens focal length. T-Stops are most often used in high-level professional cinematography and generally not for the general consumer and amateur photographers. (ASC Manual, p. 174).

⁶ It should be noted that studies are ongoing to determine which lens was used for the PGF. Until these are completed both alternatives are described and considered.

⁷ In 2010, Munns organized a frame-by-frame inventory from several PGF copies, and determined that the Cibacrhme numbering was incorrect. He determined that some copies of the PGF (the PAC Group) start at Frame 3, and so frame counts based on these copies differed from others by 2 frames. VFC-1 was Version One of the frame inventory, but with increasing numbers of copies scanned, and Frame 954 found on a copy for the first time, the inventory system was revised as Version Two and Designated VFC-2 (e.g. VFC-2 354, is the famous lookback frame commonly called Frame 352).

(about 300ft away from camera).

People are confused by very low resolution copies and motion blur, which is a separate factor described below, and they mistake these things for poor focus. It is their ignorance of photography which perpetuates the erroneous notion that the PGF is not in focus. Analysis clearly determines that the PGF was in perfect focus.

Adding to this misapprehension, people are often confused by watching video programs or video clips of the PGF, and seeing blurred frames. What they fail to understand is that the original film was shot at a filming speed established to be between 16-18 frames per second (fps). However, TV conversions have a speed of 30 fps. To keep the same sense of time and motion, the TV conversion process must add frames, by blending the existing frames of the source film to expand the frame count to 30 fps. These added blended frames are often a composite of two frames, and as such, the resulting image is blurred even if the two source frames were sharp. So any TV conversion is likely to generate many blurred frames.

5. Is there motion blur, from either motions of the camera or motions of the subject being filmed?

Motion blur actually occurs in most photography, because a camera shutter opens for a specific time duration, and either the subject being filmed or camera movement can cause motion blur during the time the shutter is open. Cameras on tripods reduce or eliminate camera motion blur, but the subject may still move and cause blur. A faster shutter speed reduces subject motion blur because it reduces the elapsed time the shutter is open, but changing shutter speeds is more common with still photography than cinematography. Higher end professional film cameras do have variable shutters that can open to nearly 180 degrees of the 360 degree shutter rotation and

close down to lesser portions of that 360 degrees to decrease the shutter time and reduce motion blur. A decrease in shutter opening time must be compensated for either by more light, a lower F-Stop, or a more light-sensitive, or "faster" film, which will likely be more grainy than a "slow" film. One of the Hollywood standard top-of-the-line cameras of the era, the BNC Mitchell, has a variable shutter from 175 degrees (widest open) to 0 degrees (fully closed), in 10 degree increments (ASC Manual, p. 94). Another highly respected professional camera, the Arriflex 35-2CV has a variable shutter angle from 165 degrees to 0 degrees. (ASC Manual, p. 105)

The PGF camera had a fixed shutter, so the shutter speed was determined by the chosen filming speed (16 fps, 18 fps, 24 fps, etc.) Thus, as an example, if a 16 fps setting is chosen (the slowest camera speed for the Kodak K-100) the shutter opens for approximately 1/32 of a second. For hand-holding a camera, and especially running while filming, 16 fps is a shutter speed guaranteed to produce some motion blur, and the PGF reflects this.

If motion blur is caused by the camera movement, the blur is global (affecting the entire frame image equally) and directional (in the actual direction the camera is moving). But motion blur can occur for a few frames and then subsequent frames can be completely sharp and clear, and we see this in the PGF, indicating the motions were sporadic. During the portion where Patterson planted himself and held his camera steady, during the lookback sequence, the imagery is generally remarkably sharp (Fig. 8).

There is the secondary issue of motion blur of the film subject, because even when Patterson is holding his camera steady, the hominid body is walking forward and the arms and legs are swinging in motion of a walk cycle. The hands and feet are the fastest moving parts of the body in a walk cycle, so the feet do tend to blur more than the torso or

head, and the hands tend to be the least sharp aspects of the arm. People who try to analyze the feet of the PGF hominid do sometimes fail to factor foot motion blur into their analysis and this can negate conclusions drawn about the feet, such as their dimensions, or visibility of toes.

There is no correction for substantial motion blur, and the film frames with motion blur are thus of lesser evidentiary usefulness than the sharp ones. This does not fully negate their value, just restricts their usefulness to forms of analysis where the blur can be accounted for. For example, if some vertical elements of the Bluff Creek landscape are being evaluated, and the motion blur is purely horizontal, the vertical relationship of landscape masses and objects would not be altered and the image would still have evidentiary value for issues of vertical relationships.

Putting this into perspective, the PGF contains 954 known film frames (by the VFC-2 system) and about 400 of those are sharp images, and the remainder has some noticeable degree of motion blur. Those sharp images still represent a very substantial inventory of image data, irrespective of the limited data of the blurred ones. So while people watching the film projected in real time tend to notice the motion blur and thus have concerns that the film's evidentiary value is hindered by the blur, when studied frame by frame, the wealth of sharp image data is more fully appreciated.

Indeed, the PGF does contain considerable motion blur, caused by both camera motion and filmed subject motion, but there are enough sharp film frames to insure the film in its totality is an excellent evidentiary resource for analysis.

6. Are there sufficient varying camera angles to allow an accurate and reliable three dimensional reconstruction of the filmed event?

The principle of taking two-dimensional photographic data and reconstructing a three-dimensional object or landscape is commonly referred to as the science of stereo-photogrammetry. It has many applications, from mapmaking to accident investigation, and is now widely used in media CGI (computer graphics imagery) to take filmed footage and analyze the objects in the scene and the camera's movement in the scene, so digital elements can be composited into that scene and appear as if they were actually there during original filming. So the process is well-established today in many varied applications.

In essence, the process requires a certain number of photographs of the landscape or object in question, and from several varied views, to allow for three-dimensional reconstruction.

In doing such an analysis, there are some software products which facilitate the process, but are constrained by certain camera/lens calibration protocols to work. But the basic principles can also be applied by reducing the task to basic principles of optics and manually working through the problem. Those principles include:

1. **Line of Sight.** A distant object directly behind a nearer object forms a true line of sight from distant object through nearer object to camera. No lens distortion will affect this true line of sight.
2. **Distance.** If a camera moves directly forward, and maintains a line of sight for some identified objects, those objects will increase in size, but the nearer objects will increase at a greater rate than distant objects. So the different rates of change in size are a direct correlation to the relative distance separating the near and far objects from the camera at its near and far position.
3. **Perspective.** When a camera moves left or right, up or down, changing perspective, near objects shift in the opposite direction, more so that more distant objects, and the

shift is inversely proportional to the object distance.

From these basic principles, three-dimensional information is extracted from the various photographs and as objects are verified in relationship to other objects, a three-dimensional relationship is developed.

When we consider the photographic resources of and related to the PGF, the amount of usable data is actually quite astonishing. The PGF itself has the camera operator moving through the landscape in many different positions and varied camera angles over a course of more than 100ft. Then we have John Green's filming of Jim McClarin in 1968 walking a path similar to the PGF Hominid from a close but slightly different camera angle than Patterson's position filming the lookback. Then Green filmed McClarin in the landscape from two other camera positions varied from the walk filming. Then we have film footage of Rene Dahinden holding a scale bar in the landscape in 1972 from another camera position about 20 feet closer than Green's position. We also have multiple still photographs taken by Dahinden and Peter Byrne, on various site visits from a multitude of varied camera positions. And we have measurements taken by both Green and Dahinden in their visits.

Further significant site evaluations were carried out by Steven Streufert and Ian Carton in 2009, adding Robert Leiterman, with contributions from Rowdy Kelley and Jamie Schutmaat in 2011. New measurements taken in July 2012 by Munns and a team of researchers⁸, with many specific and identifiable landmarks (trees, trees stumps, etc.) still very clearly identifiable and measureable, with assurance that they did not move since 1967.

⁸ Cliff Barackman, Rowdy Kelley, Ian Carton, Todd Hale, Jaime Schutmaat, Robert Leiterman, Francis Leiterman, Bart Cutino, Terry Smith, Bill Munns, James "Bobo" Fay, Daniel Perez, Scott McClean.

This wealth of photographic data and actual site surveys combined allows for an excellent 3 dimensional reconstruction of the Bluff Creek event landscape as it was in 1967 when the PGF was taken.

7. Can the camera positions be determined with factual certainty in relation to the landscape?

While the average person looks at a photograph or motion picture film and is generally aware of what is seen in the image, a photographed image actually tells the trained analyst something about the camera as well. A camera taking multiple views of a subject or a motion picture camera moving through an environment while filming tells a great deal about what the camera is doing or where it is positioned in relation to the subject seen in the image.

The extent to which information about the camera (and the person operating that camera) can be determined is dependent on movement of the camera in the environment to produce varying perspectives of the filmed subject. So in that matter, every case is unique, but basic principles apply which are scientifically and optically standard and irrefutable. One issue to clarify is that such an analysis of the camera position in relation to the objects seen in the film footage is that the analysis does not scale the objects or positions in real world measurements. It determines a conceptual relationship which is proportional, object to object and object to camera. Something in the photographs of a known size, or some actual measurements from the site photographed must be introduced to scale the camera and object positions in real world measurements.

Appendix 3 illustrates how information is extracted from images to make determinations about where the camera is, as well as where objects are in relation to both each other and to the camera positions.

The image data in total from the PGF is

sufficient to determine the path of the camera through the Bluff Creek environment during the filming of this encounter.

8. Can the walk path of the filmed subject be determined with factual certainty in relation to the landscape?

Determining the path of the filmed subject follows the same principles as determining the landscape and determining the camera positions, and is in fact dependent upon these two actions being done first. But determining the path also requires some irrefutable link between the filmed subject and the landscape.

Size of the subject in the picture becomes the basic factor defining how far away the subject is from camera. The larger she is, the closer she is. The smaller she is, the more distant she is. That establishes a proportional distance at any given image frame number and corresponding camera position. Then line-of-sight studies look where the camera is and what is behind or in front of the filmed subject for positional consideration through the landscape. The “anchor”, in this case, is two shadows cast on her body by two trees she walks behind, after the lookback. One shadow cast as she passes the second tree is so close to the tree itself that it can only be made if she is literally rubbing her shoulder against the tree as she passes it (Fig. 9).

A walk path generally has a continuum of direction or a smooth arc of curvature. Nothing in the film suggests the walk path included the subject making sudden jumps sideways or any kind of “zig-zag” changes of direction. So once key positions of the walk path are determined, the sections in between can be interpolated according to directional lines or curves. The data in the film is sufficient to accomplish this.

9. Can the position of the filmed subject be determined in relationship to the camera position?

Once both camera path and subject path are determined, in relation to the landscape, determining the interrelationship between the two is elementary. This determination is especially crucial for determining what the body angle is, in relation to camera to subject line-of-sight, because this angle is essential in determining body proportions, especially breadths and depths.

10. Can copy artifacts and physical impacts and alterations of the film material (such as scratches, water stains, and dust or lint particles on the film) be accounted for?

Copy artifacts do occur in film copying, due to a multitude of causes. Dust, lint, and other debris, even at microscopic levels, can appear on 16mm film as visible shapes, lines, dots, or other imperfections. Scratches and imperfections in the emulsion layer can also produce image artifacts. The solution to identifying image artifacts from the copy process is to have as many samples from all the copy groups as possible, and a frame inventory so any individual frame can be positively identified and then compared across copies. If we see an artifact on one copy, or among one copy group, but not on other copy groups, we can be confident that the image data is artificial and was introduced in the copy process.

A notable image artifact is the apparent curled “fingers” seen in Cibachrome F352 (VFC 354). The apparent curled “fingers” do not exist on any other copy group sampled for that exact frame (Fig. 10). It is unique to the Cibachrome copy, and thus is dismissed as a copy artifact, and not a true image feature of the PGF subject’s hand.

A second image artifact, which resulted in some outrageous theories commonly called “The Massacre Theory” (with allegations that guns were fired as the PGF was being filmed and sasquatch were being hunted) is a light flare on one frame of one of the Green copies.

When it was converted for TV broadcasting and the conversion introduced some frame blending, the light flare spot looked sharp on one frame and half faded the next, before disappearing. Some analysts claimed this was a “muzzle flash” of a firearm being discharged (Fig. 11). However, examining the specific frame across multiple copies identified that the bright light flare spot was not on other copies, just on a single copy from John Green’s inventory, and that there was no faded second flare on the subsequent frame of a true copy. The absence of a flare on any other copy removed it from any prospect of being on the camera original, and thus was not true image data. The second faded flare was simply a result of an analyst using frames of a TV scan instead of a true film scan. There is no evidence that a gunshot was fired at the time of filming.

So in this analysis of the PGF, we have the necessary data and methods to identify image artifacts, and once identified, remove them from the analysis of evidence.

11. Are there any other ways film image data can be tampered with?

When we think of “tampering with film”, the general concept is to create some type of false image element that was not on the camera original and make it appear authentic on copies. In 1967, the techniques were rather limited, as compared to today’s image compositing technology.

Photo re-touching has been a well-established art form long before the PGF was filmed in 1967, but photo re-touching, which involves actual painting on a film print, negative or transparency, is rarely attempted on the scale of 16mm film. Using a true paint brush, you would need a brush with literally only one hair fiber and a microscope to try and paint any kind of image alteration. The alteration would have to be repeated consistently frame after frame. It is doubtful

that anyone has ever accomplished it successfully. Most re-touching work was traditionally done on much larger format images, such as 8x10in negatives or prints. A film frame, a mere 0.3in high and 0.4in wide, is far too small for human ability to successfully paint on and be undetectable. Therefore, photo re-touching, while common for still photos, was rarely tried and even more rarely successful for 16mm or even 35mm film media.

Rotoscoping is a second technology used to alter film images, and it entails a projector, which projects a single frame onto a ground glass surface so the image is visible, and a cel (a cellulose acetate sheet with pin registration) is painted upon as it overlays the projected frame. Once all the cels are painted, frame by frame, they are photographed and composited onto the original film and the painted effect is introduced. In 1967, this was challenging to do with any level of realism, and particularly ineffective if the filmed image varies in sharpness and motion blur, as the PGF does. Also, the composite process was more successful with 35mm film than 16mm film. So the PGF contains no image features which could be attributed to rotoscoping technology.

Traveling matte composites is a third technology of the time and is described in detail in the ACS Manual (pp. 555-578). Two criteria for any successful traveling matte effect were that first, the original camera must be locked down solidly stationary and second, the film must have a continuous level of focus and lack of motion blur. The PGF has neither, and so it has essentially no potential for being altered undetectably by the traveling matte system.

Once printed as a still image, individual film frames have occasionally been altered. The famous “lookback” frame (“frame 352,” VFC 354) has become a public domain image, and has been used in numerous forms in various media. In March 2012 the magazine *Vanity Fair* (p. 126) printed the image, but an

obviously re-touched version of the true frame image (Fig. 12). So re-touched or altered individual frame images do exist, and so it is always best to go back to true film frame scans to verify if still images are authentic or have been altered.

Patterson sold zoomed-in prints of frame 352 (VFN 354) to members of the Northwest Research Association. These included an 11x14in black and white print and a 5x7in color print. Meldrum is in possession of a set of these. The provenience of these prints relative to the film copy groups is not certain, but the clarity of the prints is exceptional and true to the film original, providing yet another check on image data integrity.

SUMMARY

1. The camera original was not spliced or edited in any way when the copies were made. Thus the copies are a true representation of the camera original and can be studied as truthful depictions of the filming event.
2. The film resolution is excellent, and has resolution as high as any 16mm film of its time. The detail is reliable and as much as one could expect for 16mm film.
3. The manner in which the copies were made maintains the image integrity of the original, with some allowance for slightly diminishing levels of detail. The copies are more than sufficient for analysis in the absence of the camera original at this time.
4. The film was in excellent focus. No

criticism of the image data can be attributed to poor focus, and the popular notion that it is blurry beyond credibility has no merit.

5. There is significant motion blur in portions of the film, but there are hundreds of frames without any such blur. There remains an abundance of evidentiary material to work with and even some of the motion blurred frames have evidentiary value for some forms of analysis.
6. Among PGF film itself, and other films and photos of the site, there are more than sufficient different perspectives to make a three-dimensional reconstruction of the landscape.
7. The extensive camera motions are highly conducive to analysis of the movement of the camera operator throughout the filming.
8. The path of the filmed subject can be reliably calculated from the film image data and placed into the landscape in a correct position relative to verified landmarks.
9. The inter-relationship of the camera operator and the filmed subject can be reliably analyzed frame by frame.
10. Image artifacts can be reliably identified and eliminated from consideration so no false data need be introduced.
11. The methods available for altering 16mm film at the time were inadequate for falsifying the image data in any way undetectable to modern technologies.

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- Mascelli, J.V. (ed.) (1966) *ASC Manual*, 2nd ed. Hollywood, CA: Official Publication of the American Society of Cinematographers.

APPENDIX 1.

Citations of audio “pop” from a horizontal cut and splice of magnetic audio tape or film, and why a diagonal cut reduces or eliminates that “pop” (Churchill, 1971, pp. 7 and 75):

<http://www.folkstreams.net/vafp/clip.php?id=54>

<http://www.youtube.com/watch?v=bzhST6WdIk0>

<http://www.tpub.com/journalist/165.htm>

APPENDIX 2.

ASC Manual - The American Society of Cinematographers, a Hollywood professional society formed by the most accomplished and experienced cinematographers, published a professional industry reference manual. It was often referred to as “The Cameraman’s Bible,” and the factual integrity of its content is impeccable. The second edition, published in 1966, is specifically cited herein, even though there are newer editions available, specifically because the PGF must be analyzed in reference to technology of the 60’s. The second edition was published one year before the PGF was filmed, so it is the most accurate reflection of camera, lens, film stock and other motion picture technologies at that time.

SMPTE/SPSE Proceedings - SMPTE is the Society of Motion Picture and Television Engineers, an industry group who have been entrusted with establishing and defining standards of technology and procedure for the film and television media. SPSE is the Society of Photographic Scientists and Engineers. Together, these two organizations assembled the scientific papers presented at their 1971 two-day technical seminar and published them in a reference text titled “Technologies in the Laboratory Handling of Motion Picture and Other Long Films”. The 1971 publication is relevant because in 1971, copies of the PGF were still being made by the procedures described in the text, and between 1967 (when the PGF original was taken) and this publication, all the material content could be considered accurate professional documentation of industry standards and practices when the PGF was filmed and copied.

Film Editing Handbook - Technique of 16mm Film Cutting, by Hugh Churchill (1971). This reference has multiple citations as well, but its contents are summarized here. Pp. 5-10, “Chapter 1- Splicing Film” describes and illustrates various types of splicer machines and splicing techniques. The book’s Appendix B – Equipment, on p. 161, illustrates splicers as well, and describes types of splices on pp. 165-166. The diagonal cutting of magnetic audio film tracks is noted on p. 7, paragraph 4, and described in more detail

on p. 75, paragraph 2, where the diagonal splicing reduces the “Bloop” (also called a “pop”) which results when an audio magnetic track is cut true horizontal to the film path. The text notes that the diagonal cut reduces or eliminates that sound phenomenon.

APPENDIX 3.

The following demonstration (Figures 13-1 through 13-7) shows how a camera’s position can be determined in relation to objects the camera photographs:

1. Two spheres, same size, and 2 spheres, different sizes.
2. Measure each sphere in both images and create double bar ruler for each.
3. Right sphere doubles in size, from camera a to b, so it shows the distance is half as much for b as a. so based on this, we can designate two points, a and b, for the camera, and the right sphere is twice as far as camera b from camera a.
4. Left sphere increases less, so it is further away. If the bar rulers are marked so the difference of each is the camera move, and we equalize the camera move segment, then the bar ruler will tell us how far away the left sphere is.
5. Comparing the right sphere distance to the left sphere distance, we see the left sphere is twice as far away as the right one. Yet in image one, they appear equal in size, so this proves the left sphere is twice the size of the right sphere, because twice as far away it looks the same size.

From these two images can be determined two camera positions, the relative position of the two spheres to each other, and the determined the relative size of the two spheres in relation to each other.

From these four demonstration images, we are able to calculate the size and relative position of the two spheres and four camera positions in relation to the two spheres. If there are more objects in the images and each object is seen in at least three images, we can accurately define that object’s size and position relative to the other objects. Any camera position which captures multiple located objects can itself be located.

It is this basic methodology, but extended to a much higher level of sophistication, which allows for the development of a Bluff Creek site model, which reliably locates the various trees and ground objects, locates Patterson’s camera for any given frame, and finally locates the PGF hominid in the scene relative to camera and landscape objects. The key to this analysis is understanding what the camera actually reveals about both the scene it photographs and its own position in relation to the scene, through the use of multiple varied camera positions and clear identification of multiple objects in these scenes.

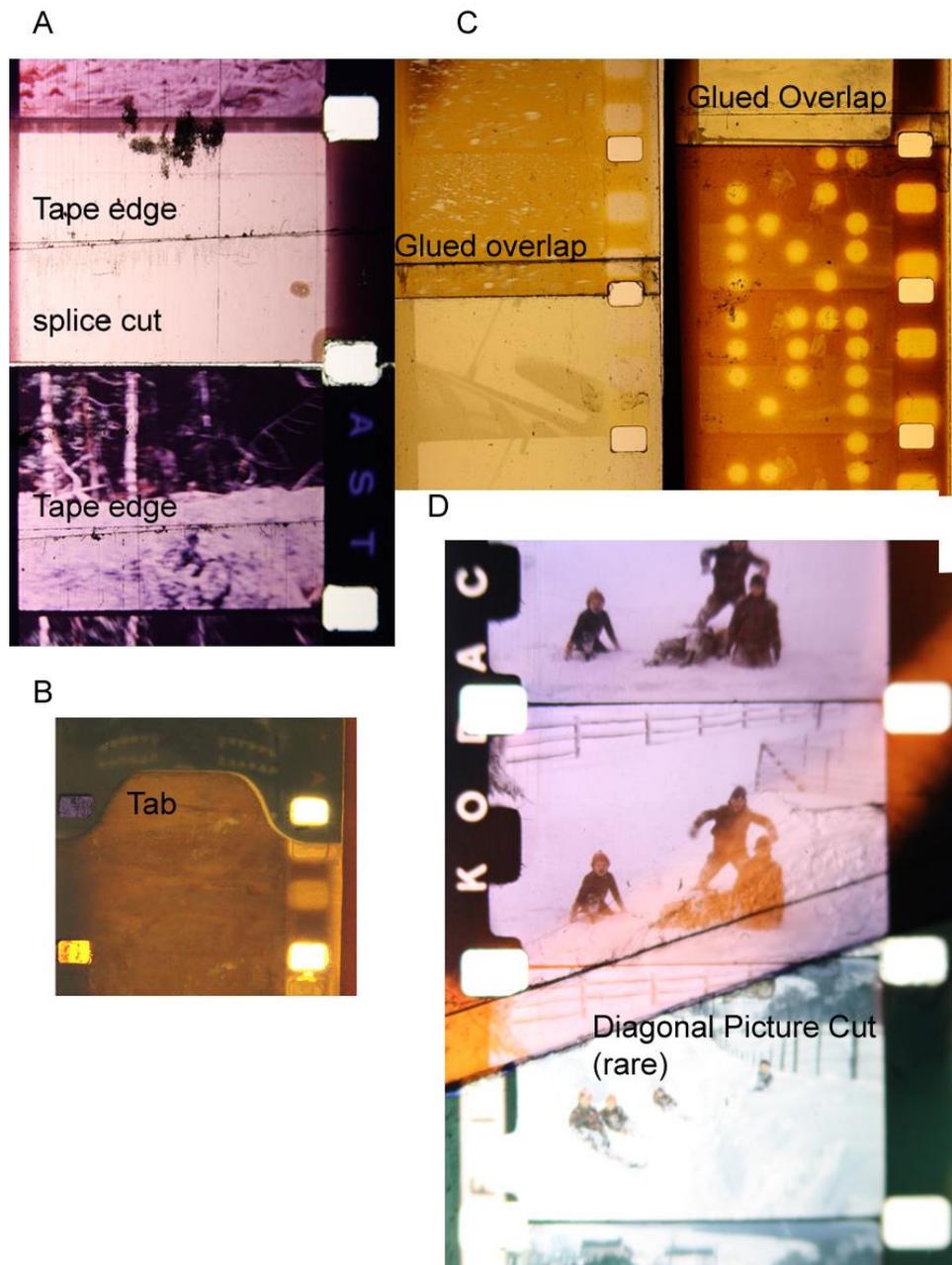


Figure 1. Illustration of various types of common film splicing techniques. A. Butt splice (the two pieces of film are butted together cut to cut) with tape adhesive as the joining medium, and both the cut line and the tape edge lines visible. B. Tab splice, usually done by film labs, primarily for leader and other non-image elements of the film footage. C. Glue splice applied to a film cel overlap, where one piece of film is cut on the frame line, but the other is cut away from the frame line so there is a physical overlap of film area to apply the glue. D. Diagonal splice intended for audio magnetic coated film stock, not picture stock, but an occasional amateur with only a diagonal splicer may use it as illustrated.

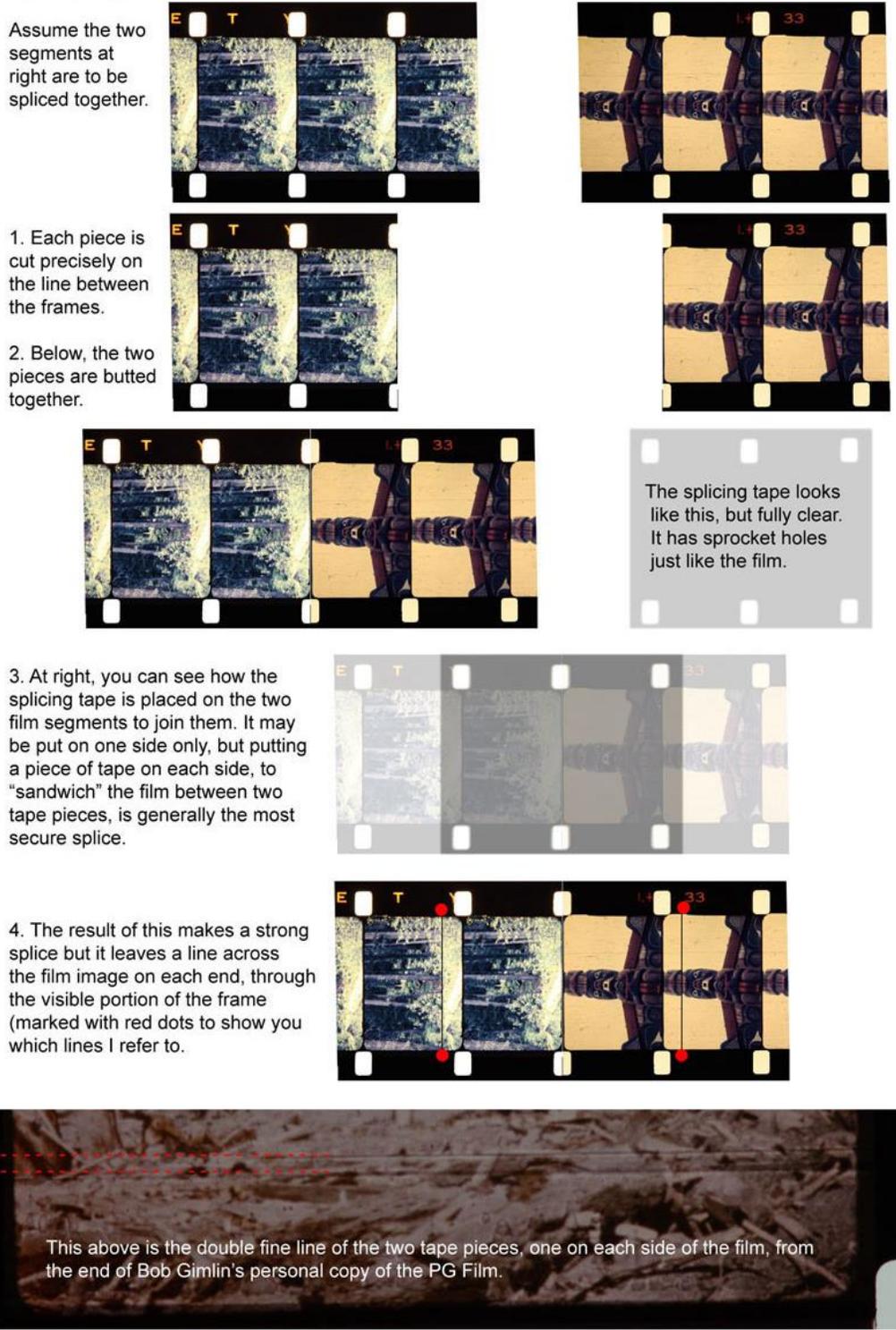
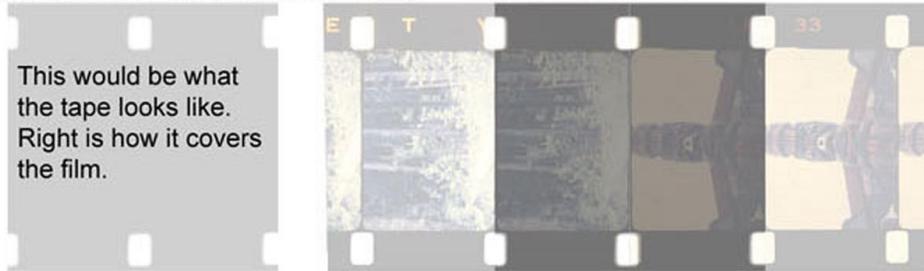


Figure 2A. Conventional tape splices. These are made with specially cut splicing tape from Kodak, which covers two full frames plus the full sprocket holes at the outer frame line of those two frames. Using this method, the tape edge line can be seen in frame when projected or otherwise viewed.

5. The concept of an “invisible splice” cuts the splicing tape exactly across the frame line, so there is no tape line in frame to see. It is hidden in the dark line separating frames.



The “Invisible Splice” Technique still does not hide the physical cut line.



Figure 2B. Technique sometimes referred to as an “Invisible Splice”. While the “invisible splice” technique does remedy the tape line in the film image area, it does not remedy the cut line and the prospect the cut line will allow a light leak onto a copy which is printed by continuous contact printing machinery. As such, the splice may not actually be invisible on examination of a copy.

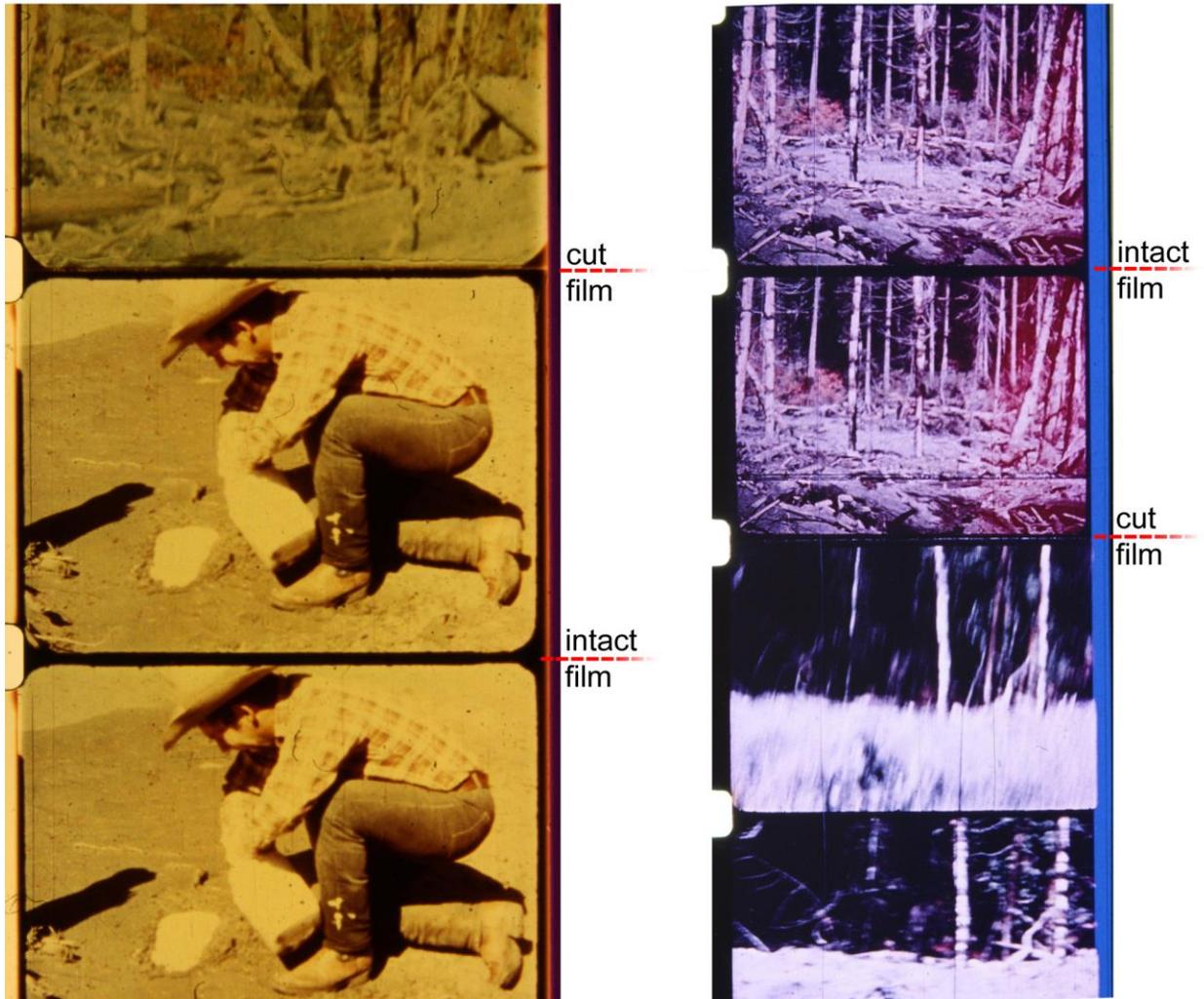


Figure 3A. Detecting splices on contact print copies: cut line printed through. Two examples of a contact printed copy show both a cut line (with white cut print-through of light) and an intact film black frame separation line.

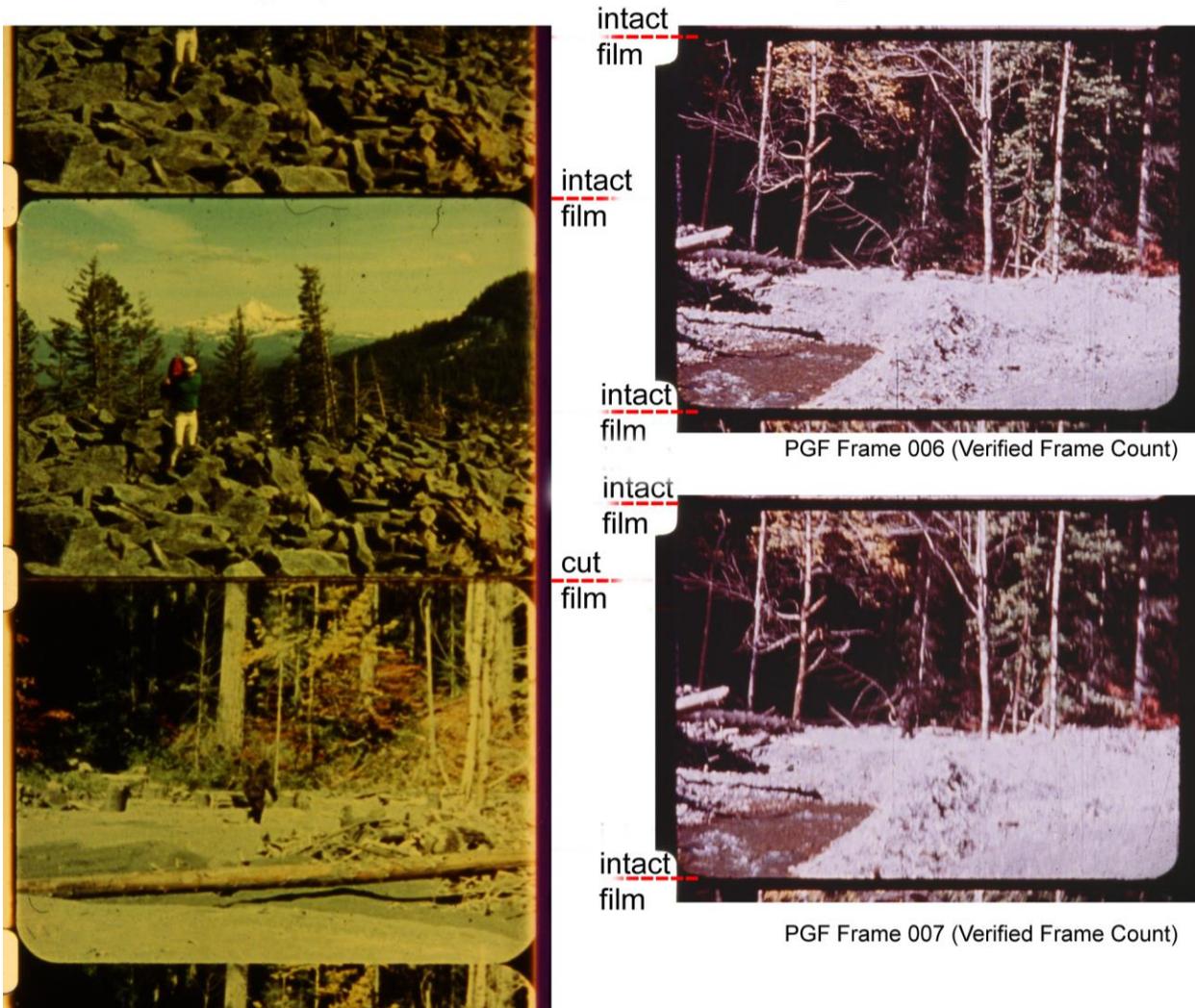


Figure 3B. Detecting splices on contact print copies: cut line printed through. Left shows a third example of the light that prints through the cut line of film onto a copy. At right, two frame scans of a PGF contact printed copy show the frame lines intact. When scanning, Munns examines each frame and sees each black frame separation line twice (once on the frame where the line is on the bottom, and the next frame scan when the same line is on top). No frame in the entire PGF copy group has such a light print through line between image frames.



Figure 4. TV splice and true frame. Some PGF copies have been spliced for specific show or program purposes, and these show versions have been converted to TV format. Image at left shows a TV conversion of one such frame with an obvious splice line. Turning at right to a PGF true scan reference copy shows the same frame fully intact, and verifies the camera original was not spliced when copies were originally made.



Figure 5A. PGF benchmark for image quality. This image is the Patterson Transparency of frame VFC 354 (mistakenly, but popularly called “Frame 352”) and it is the standard of image quality for analysis. The blue box is the study area, and two thin branches against the dark background will serve as lines to measure how fine the resolution is.

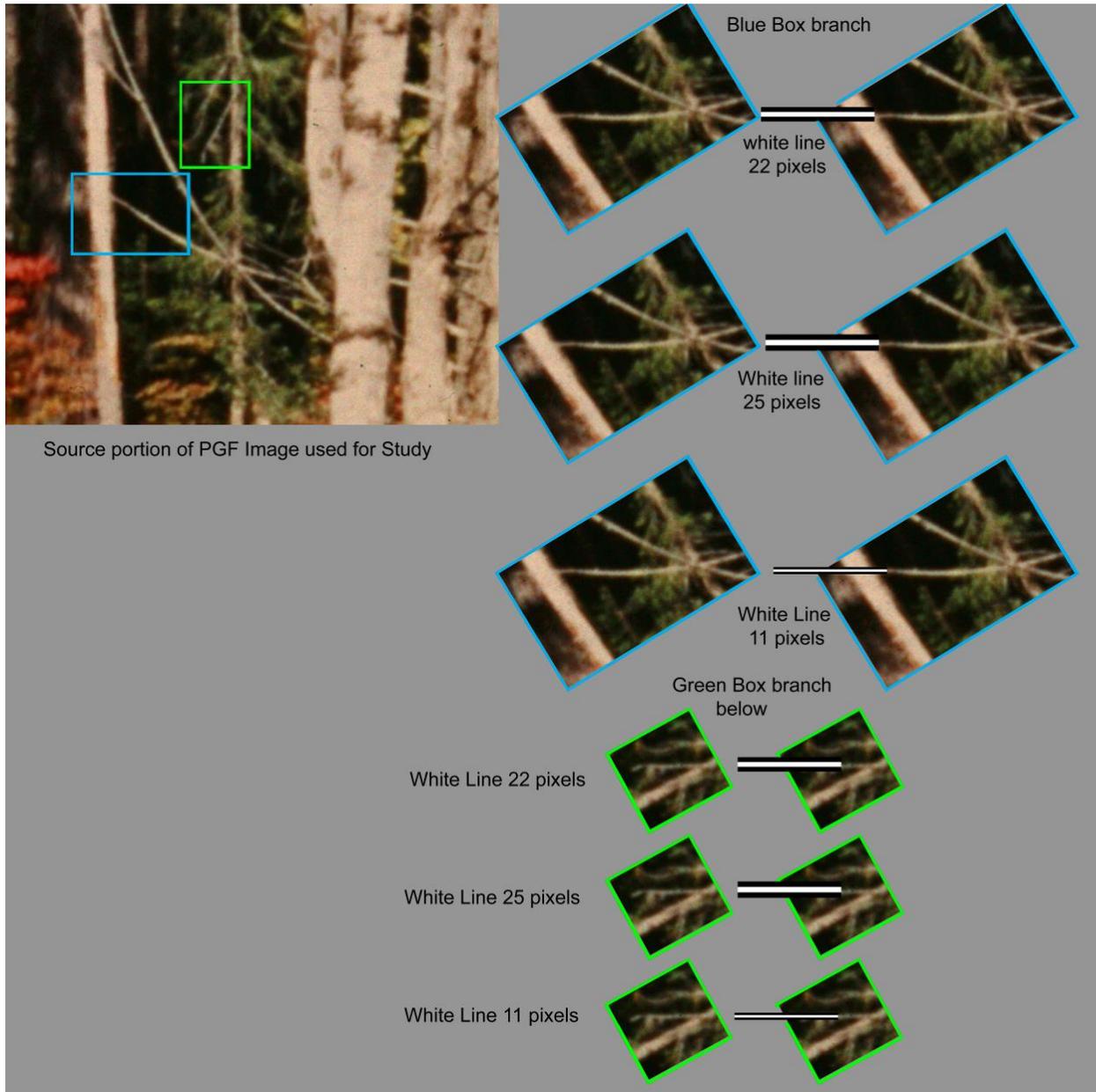


Figure 5B. VFC 354 Transparency Resolution. The study area referenced in Fig. 5A is enlarged in the upper left corner. Within it are a blue box and a green box. On right, the first three pairs of images are the blue box branch, rotated so the branch is horizontal, as compared to lines of resolution. The three pair at lower right are the branch in the green box, also rotated horizontal and compared to lines of resolution. Each branch compares most favorably to the line 11 pixels high, and a film resolution of 65 line pairs/mm scale.

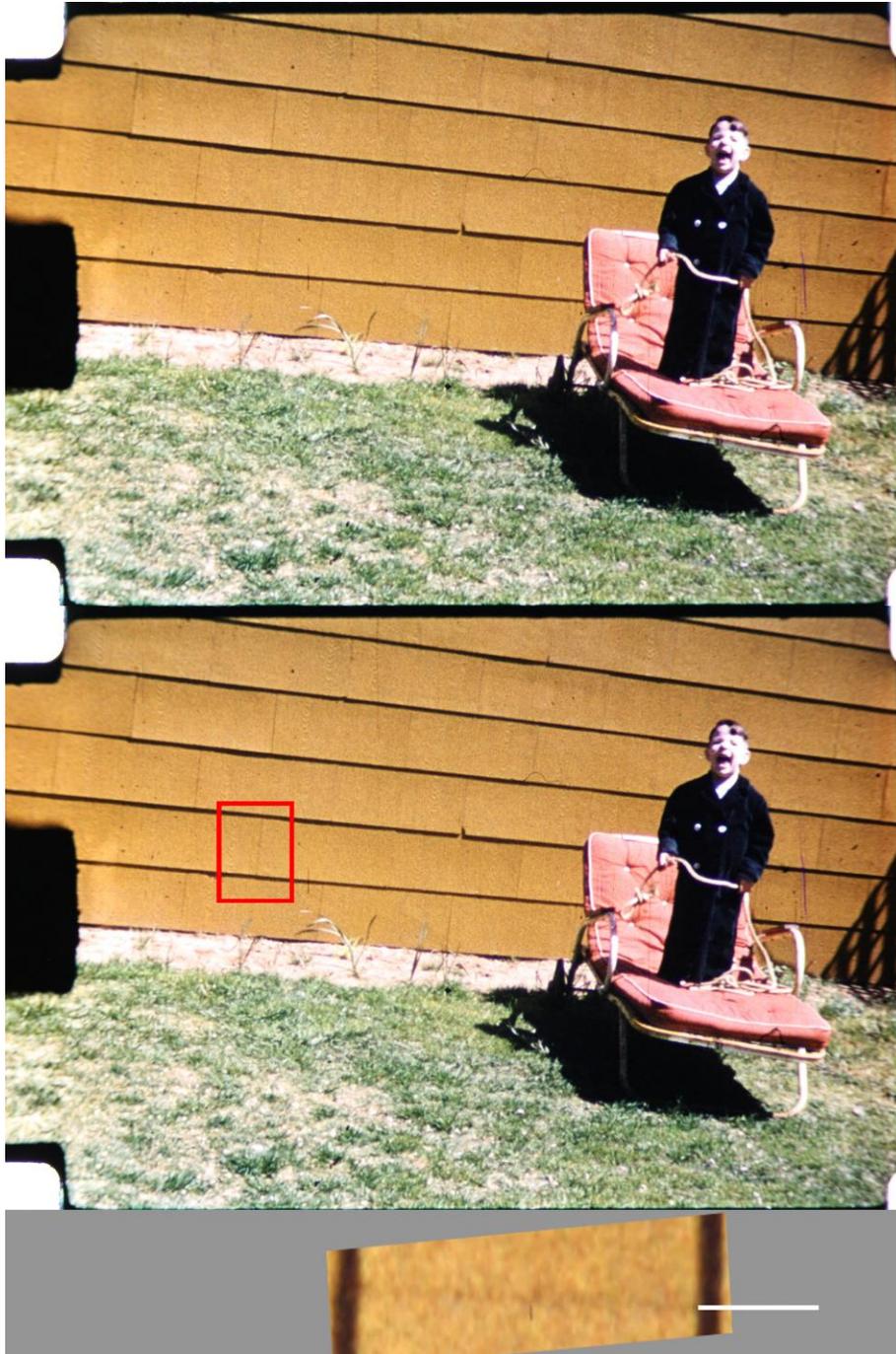


Figure 6. Kodachrome vintage movie for study. The top image shows the original scan, and the middle image shows the area selected for study (red box). At the bottom, the enlarged study area, rotated so the line referenced is horizontal, as compared to lines of resolution, is compared to a reference line 4 pixels high (which scales to a 65 line pairs/mm reference line, in relation to the image scan scaling). Resolution of the line in film (the line being the shadow cast by the lap board panels) approximates the theoretical resolution reference line, affirming the resolution of Kodachrome at about 65 line pairs/mm.

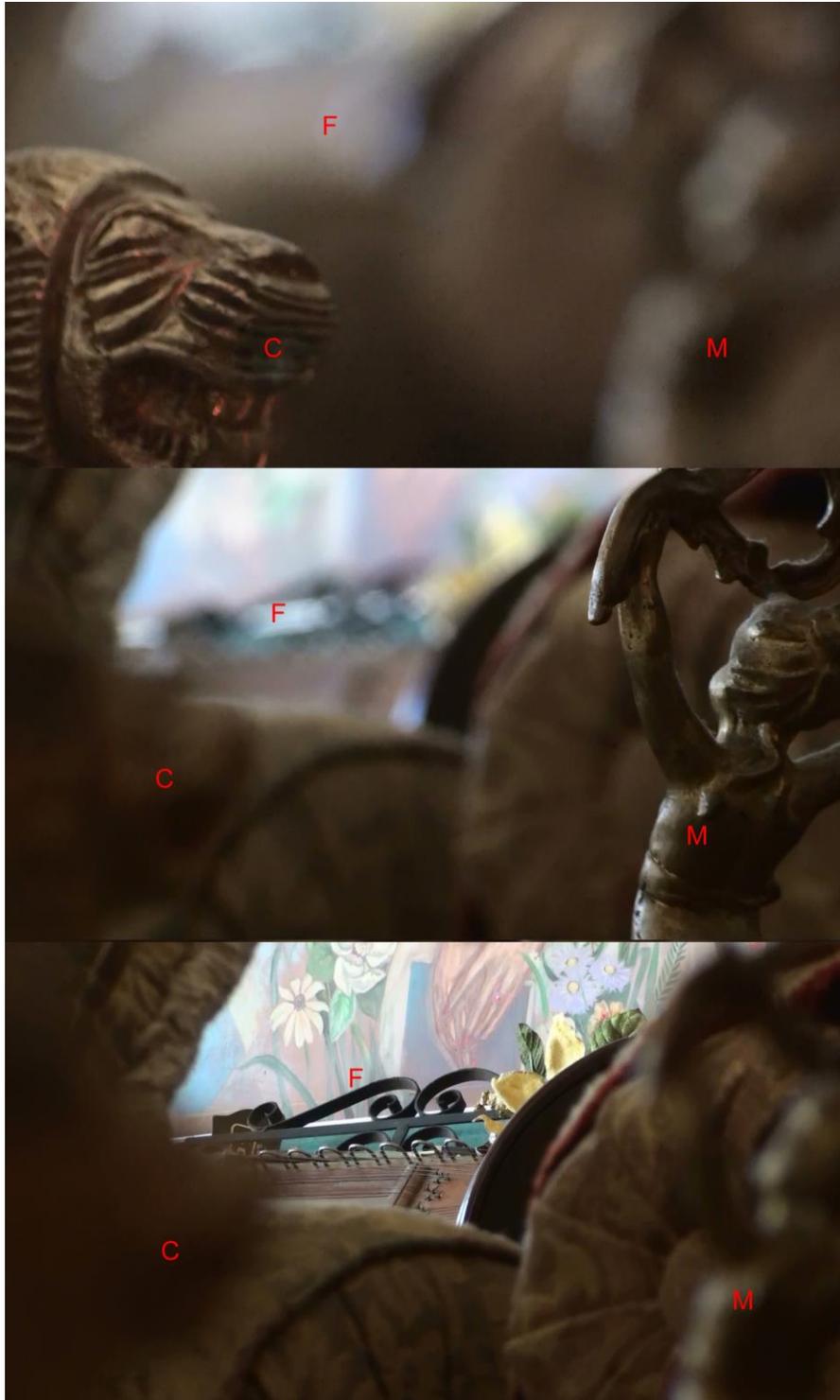


Figure 7. Focus. The top image shows the close foreground in focus, but middle and distant objects are out of focus. The middle image shows the mid-range object in focus, but both close and far objects are out of focus. The bottom image shows the distant object in sharp focus and closer objects out of focus (Key: C is close object; M is middle distance object; F is far object).

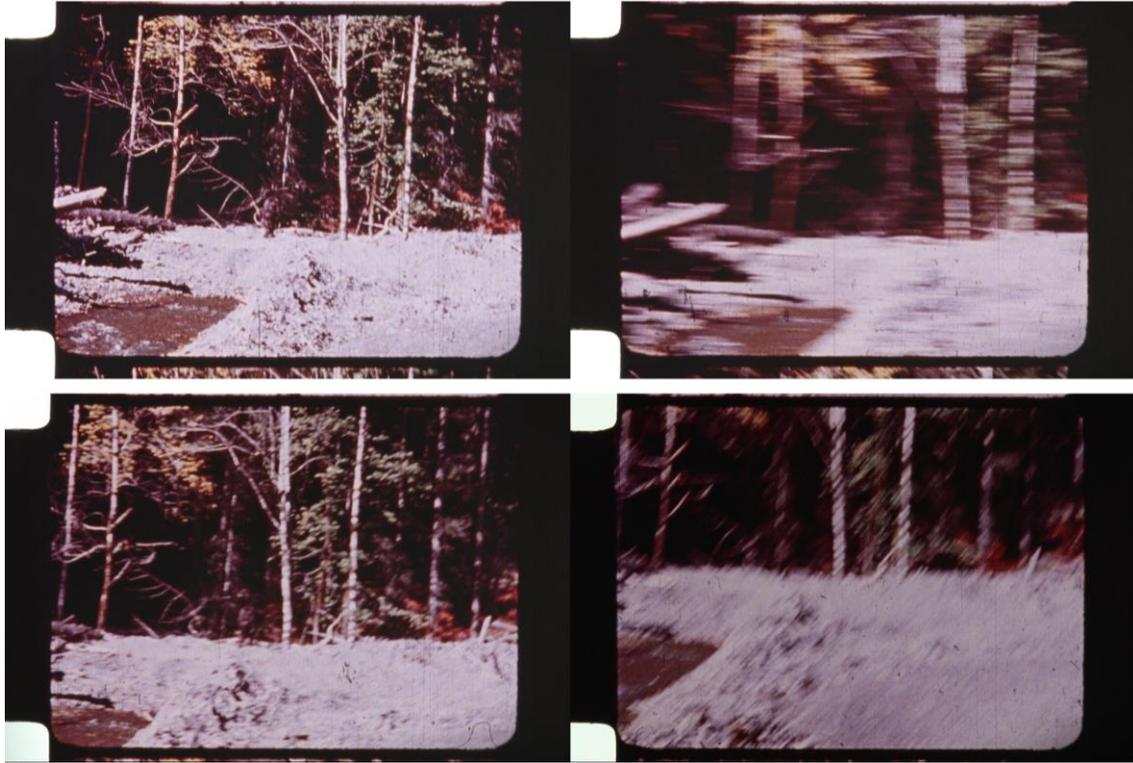


Figure 8. Motion blur. This panel illustrates PGF frames without motion blur: top left – none (pristine), bottom left, near pristine; and those with motion blur: top right – horizontal blur, bottom right – diagonal blur.

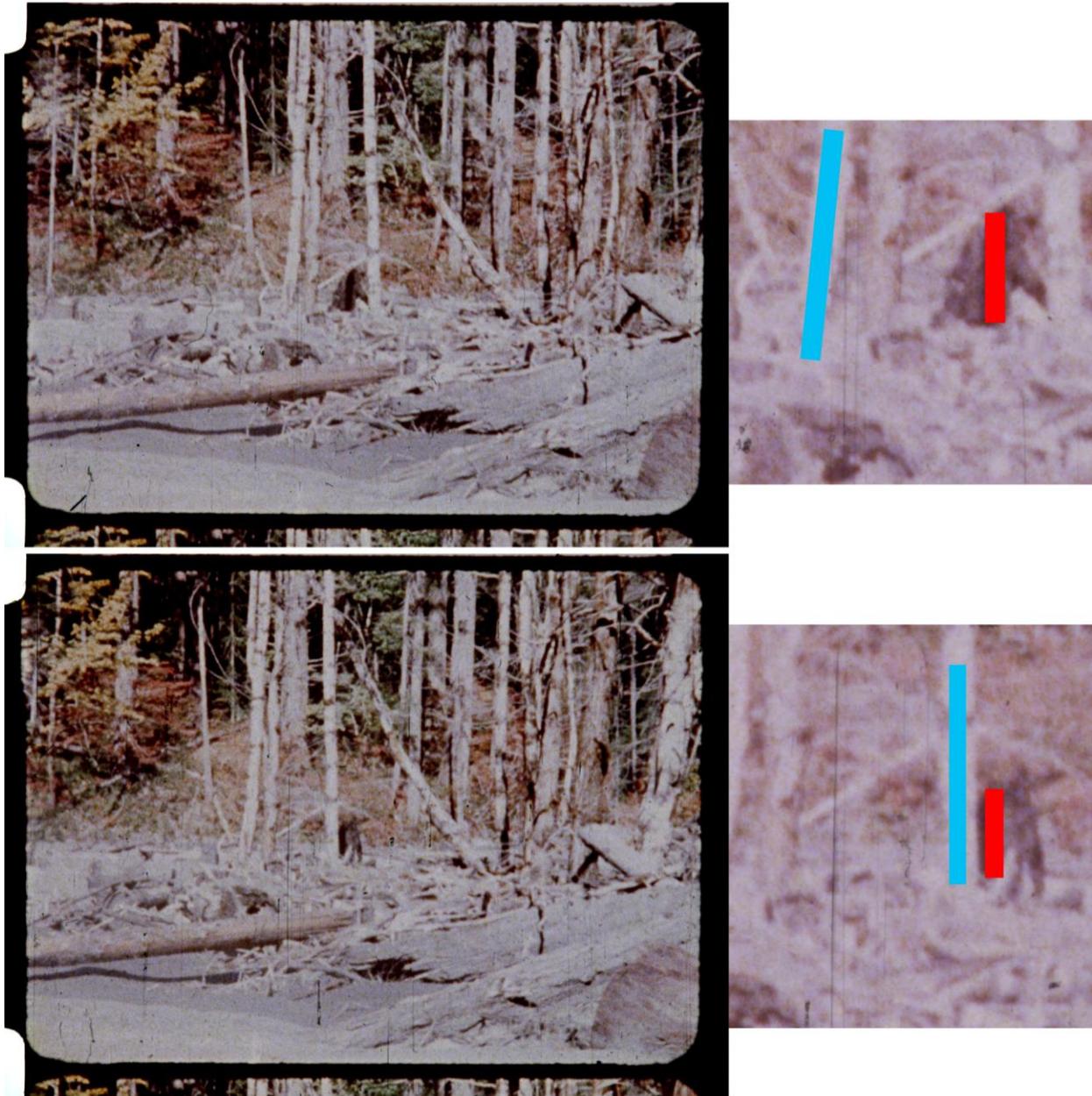


Figure 9. Tree shadows on PGF hominid. This chart illustrates the two tree shadows on the back of the PGF Hominid body, which are used to anchor the hominid's path in relation to the landscape. Images at left are the actual frame images. Images on right show the tree in blue, and the shadow of the tree on the hominid body in red. The difference between the tree and shadow positions from one tree to the next allows for a triangulation of the line of the two trees, the sun angle, and the hominid path, to fix the hominid's position conclusively in relation to the landscape.



Figure 10. Image artifact. Comparing a Cibachrome print to a film scan shows the “hand” (what has been taken by some as a thumb and finger in opposition) appears only on the Cibachrome image and not on any other copy. This verifies that the “hand” is, in fact, a copy image artifact, not a true image of the hominid’s hand.

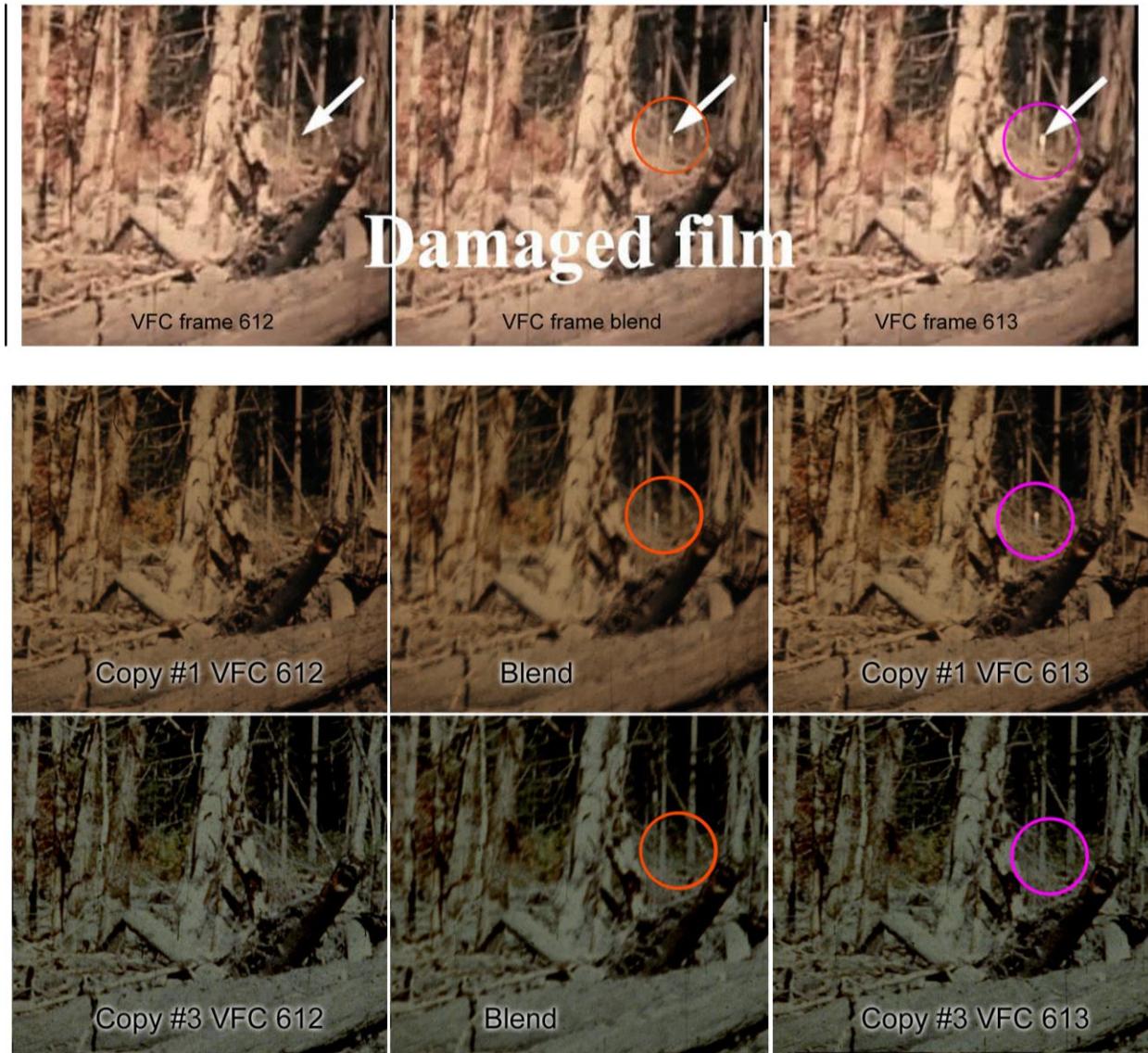


Figure 11. Image artifact. One claim in recent years suggested a light flare was evidence of a firearm “muzzle flash” when the weapon was supposedly discharged. But the “flash” has been identified as an image artifact on frame #613 of one copy of the PGF, which researcher John Green possessed, here marked copy #1. The flare does not exist on any other copies. The apparent partial flare before the full flare is actually a TV conversion frame blend of frames 612 and 613. Top row shows the basis of the original claim. Middle row shows the identified Green Archives scan with the flare in frame 613 and the partial flare produced by blending frames 612 and 613 (middle center). The bottom row shows a PAC group copy with no flare, and thus the flare is not common to all copies and was not on the camera original. So it has no relevance to what occurred the day the PGF was filmed. There is no evidence that a gun was discharged that day at Bluff Creek.



Figure 12. Retouched still image. This chart shows the famous Frame 352 (VFC 354) as it actually is in the true film, and as it is retouched by unknown persons. It is often publicly displayed in the media from a version licensed or distributed by Corbis Image Services. Upper left – true PGF copy with retouched area shown in blue. Upper right – The upper right (blue tinted) version was printed in *Vanity Fair Magazine* (March 2012 [Hollywood] issue, p. 126). Lower left – True PGF image unretouched. Lower right – PGF image retouched for ABC News website Oct. 10, 2013, crediting Corbis as the image source.

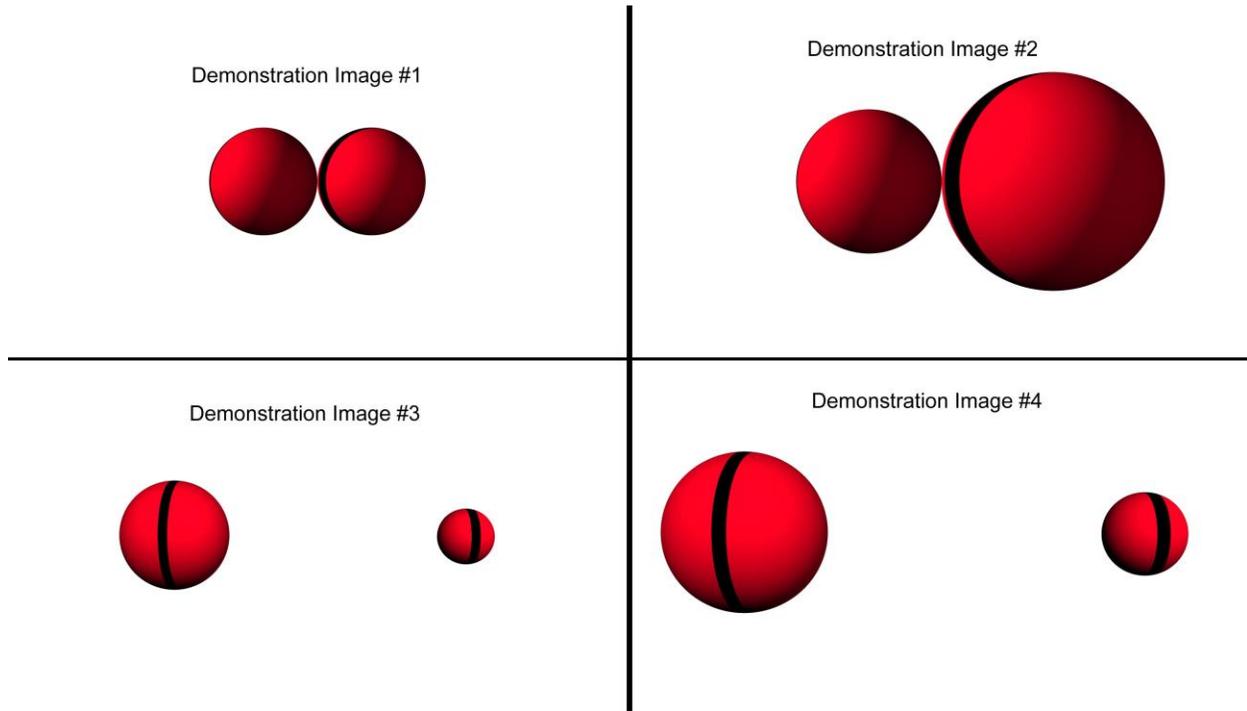


Figure 13-1. This instructional example illustrates how information is extracted from images to make determinations about where the camera is, as well as where objects are in relation to both each other and to the camera positions. There are two given conditions to this example: 1. The objects do not change size or position in relation to each other or the overall environment; 2. The camera's focal length does not change. Note that both of these conditions are applicable to the filming of the PGF footage. The landscape trees, logs, stumps and similar debris do not move during the filming, and Patterson's camera does not change the lens focal length during the filming. To begin, four demonstration images were taken of two red spheres, and the images are numbered 1-4. Starting with Image #1 alone, we would assume that the two spheres were equal in size and side-by-side, if we had no other information to rely upon. That would be an assumption, but a logical one, based on what we see. However, once we introduce a second image (#2), we see these two spheres from a different perspective and they no longer appear equal, and neither is the size it was in Image #1.

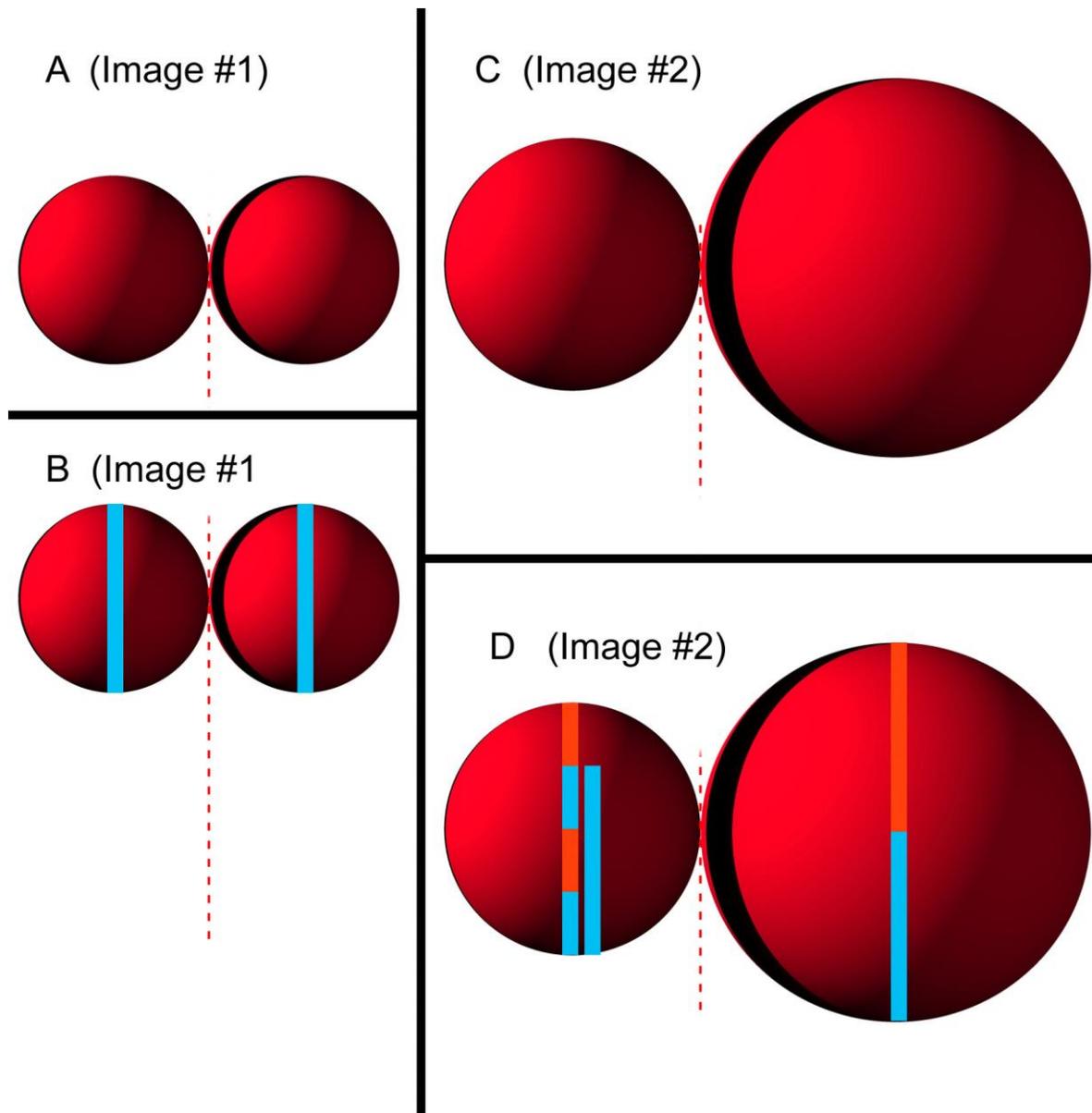


Figure 13-2. The measure of the spheres. Upper left (A) shows the first image and the spheres look alike. Lower left (B) shows both spheres measured with a blue bar. Upper Right (C) shows the same two spheres from a second camera position. Lower right (D) shows the spheres now measured and the right sphere has doubled in size, while the left sphere has increased by $1/3$ in size. Our analysis allows us to deduce that the camera position #2 is twice as close to the right sphere as camera position #1, and makes the right sphere look twice as large. But because the left sphere has only enlarged by $1/3$ for the same camera move closer, it is further away than the right sphere. The actual calculation tells us that the left sphere was twice as far as the right sphere from camera #1 position, and since it looked the same in the Image #1, it must be twice the size to look the same at twice the distance. Also, the inner edges of the two spheres touch in both images, so the line from one inner edge to the other forms a line of sight which the camera must be on for both positions.

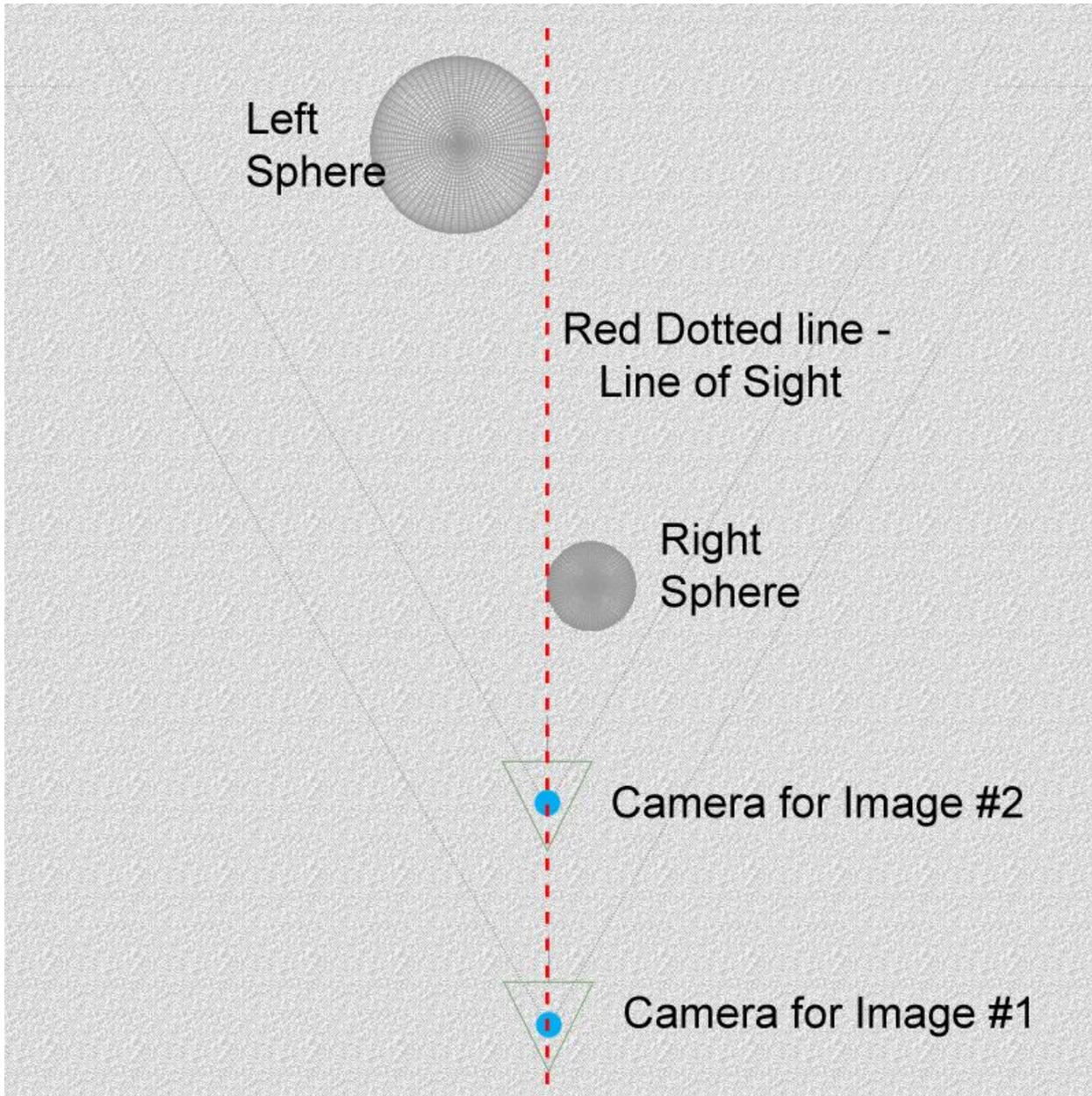


Figure 13-3. Top view of the objects and the cameras. The red dotted line is the line of sight reference. These determinations were made from the two demonstration images (#1 and #2).

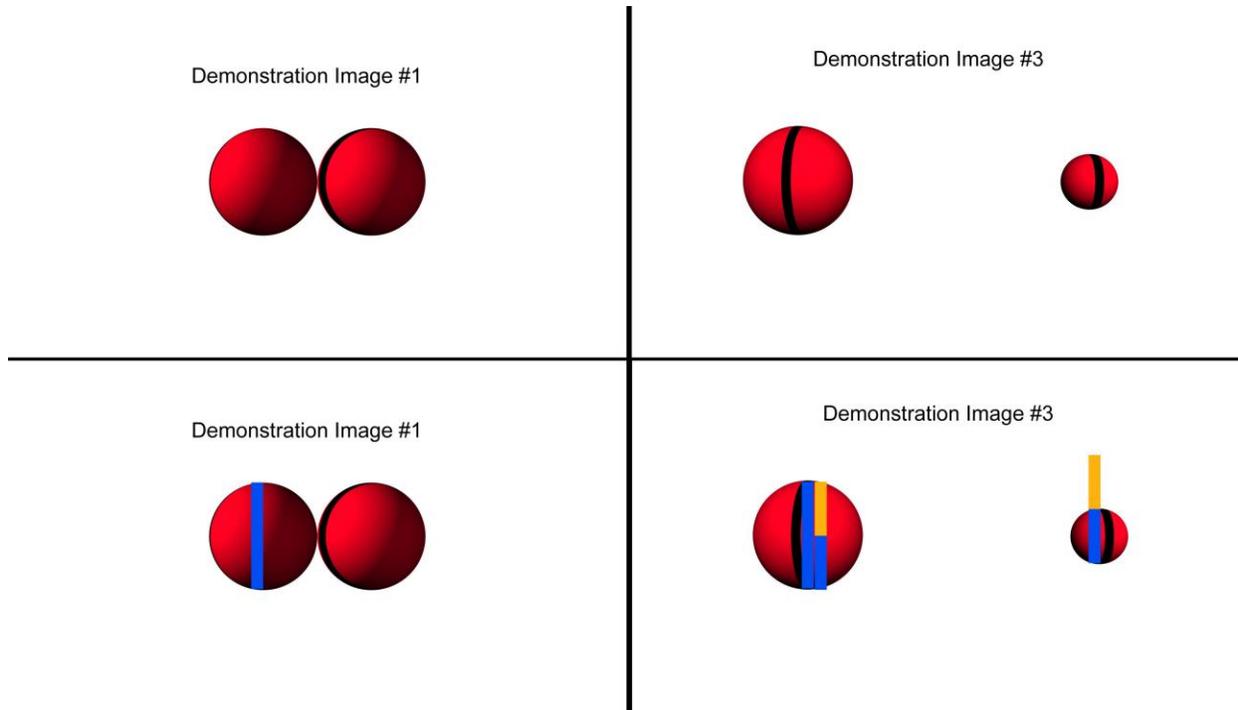


Figure 13-4. Demonstration images #1 and #3. In the lower row, we measure the left sphere (now known to be the further one) and find it is identical in size in Image #3, one full blue bar. So it is the same distance from camera here as it was in camera position #1. The right sphere is 1/2 the size of the left sphere, which we have already determined to be so, and so both spheres are shown in their correct sizes. This can only occur if the camera is equally distant from both, and that distance is the same as camera #1 was from the left sphere.

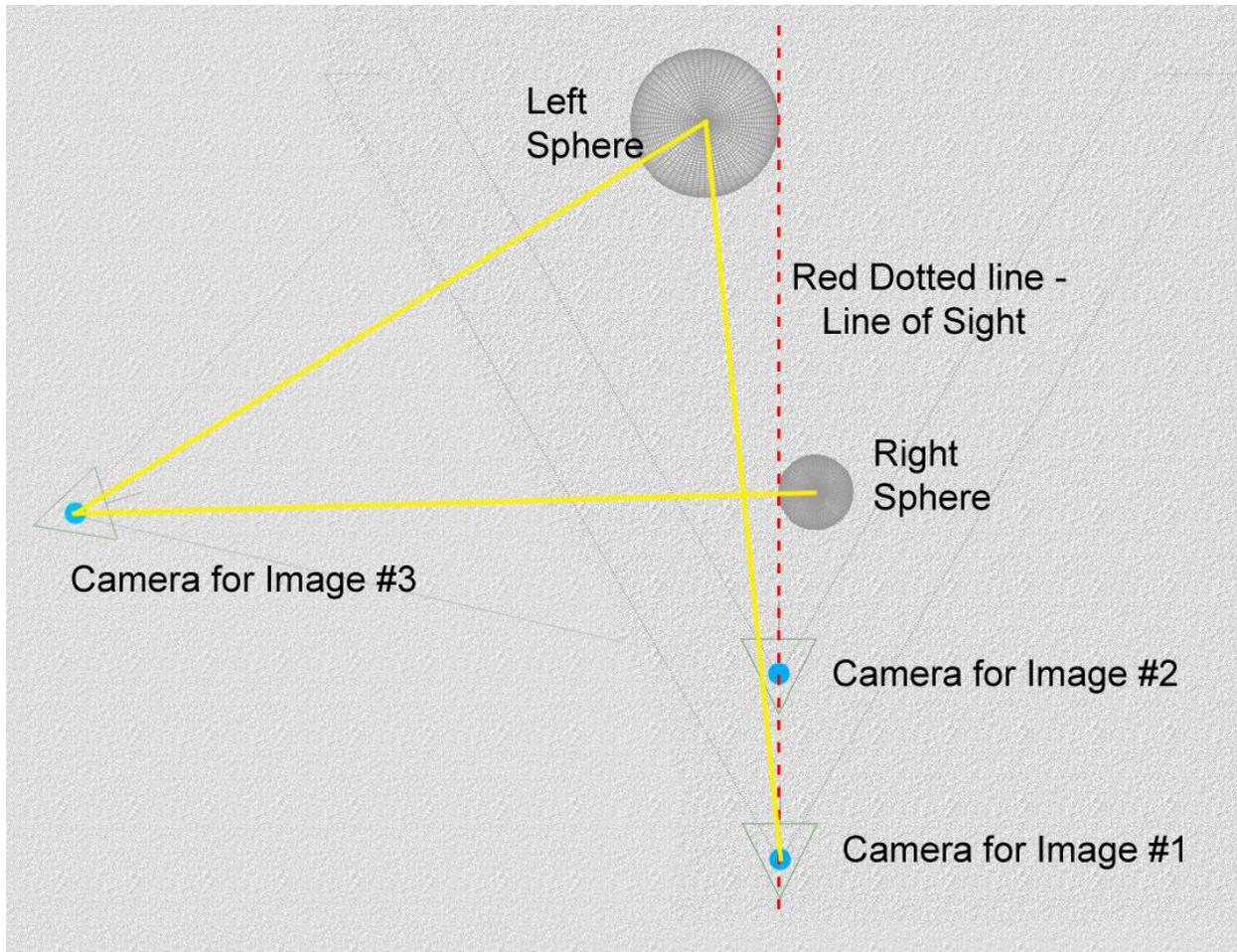


Figure 13-5. Top view of the objects and the cameras. A top view diagramming this third camera position, equally distant from both spheres, and the same distance as camera #1 was from the larger left sphere. The yellow lines diagram the distance, and camera position #3 is identified.

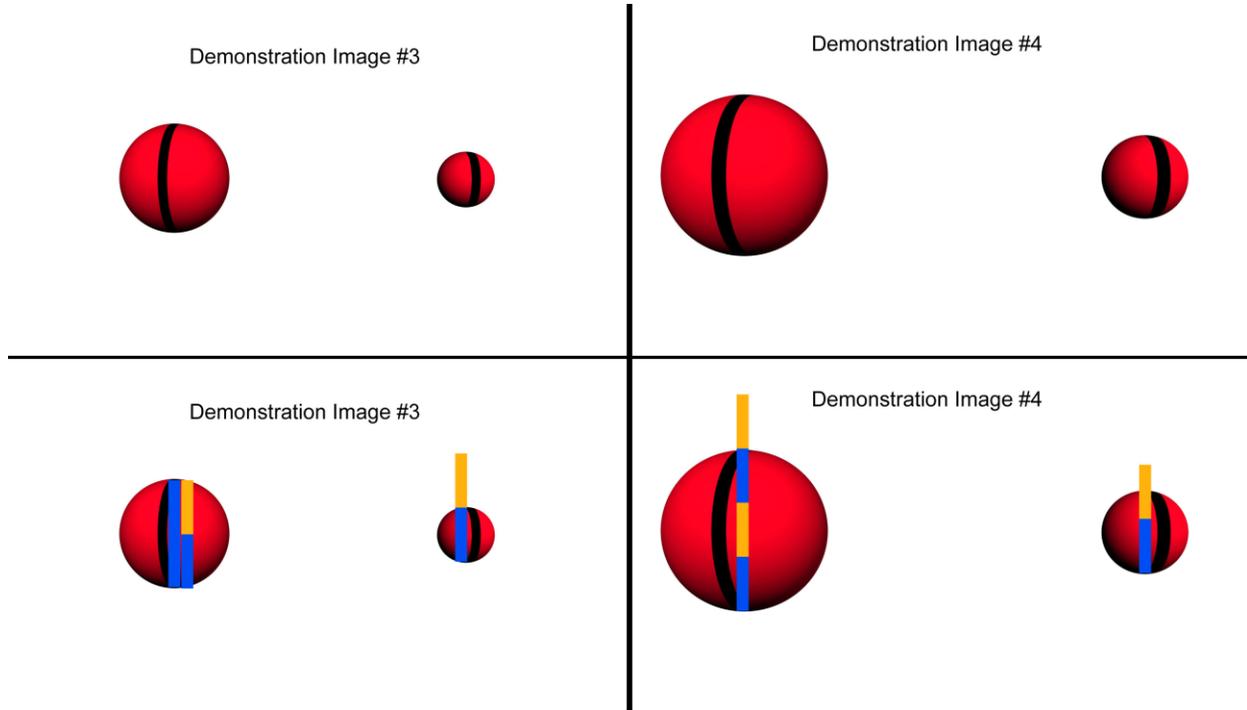


Figure 13-6. Compares demonstration image #3 and #4. In image #4, both spheres are larger, and measuring them, we find both have increased by half again as much as they measured in #3. Because both increased in size at equal proportion, we can conclude the camera is closer but still equally distant from the two spheres. And we can calculate the closer position by the sphere size increase.

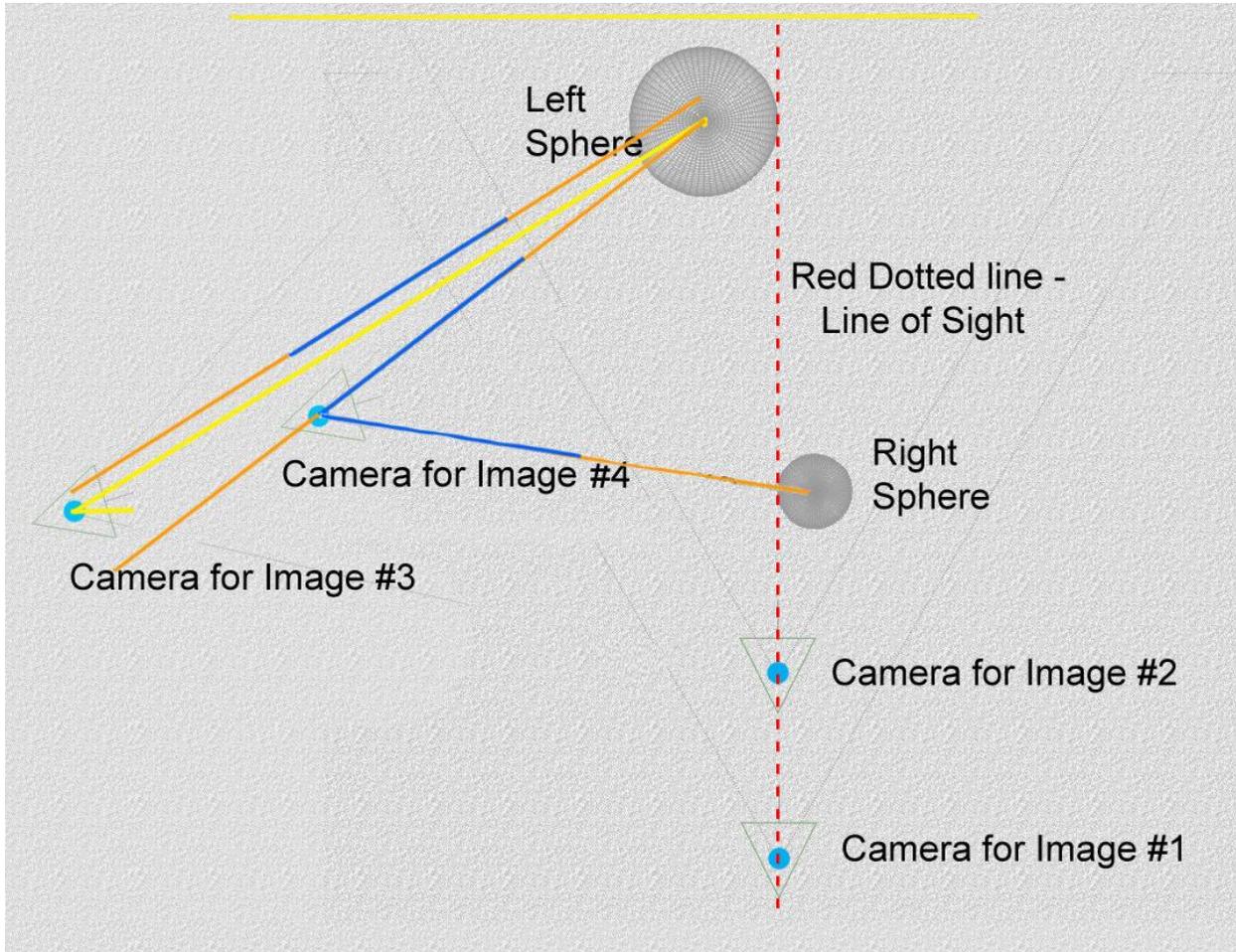


Figure 13-7. The four camera positions from a top view. We see camera #4 is closer than camera #3, but still equidistant from both spheres (at center).