



### D30 Analysis of an Image Anomaly in the Space Shuttle Columbia Accident, Part 1: Authenticating the Camera Source

*Richard W. Vorder Bruegge, PhD\*, FBI, Forensic Audio, Video and Image Analysis Unit, Building 27958A, Quantico, VA 22135; and Peter Goldie, PhD, Lightbinders, 2521 Harrison Street, San Francisco, CA 94110*

After attending this presentation, attendees will understand one means used to authenticate a digital camera as the source of a specific digital image.

This presentation will impact the forensic community and/or humanity by demonstrating to the forensic community one of the many

ways forensic scientists are conducting analyses of digital evidence, and will see how forensic image analysis is a field with a broad application.

The presentation will describe the analyses used to confirm that five (5) digital images depicting the Space Shuttle Columbia (STS-107) during its atmospheric reentry on February 1, 2003 were taken with a specific camera. One of the digital images examined in this case included an anomalous feature some thought might be related to the accident, either as a cause of the accident, or as documenting the breakup of the shuttle. A description of the analysis used to determine the source of that anomaly is included in a separate presentation ("Part 2").

On February 1, 2003, the Space Shuttle Columbia (STS-107) was scheduled to return to Earth after an extended stay in orbit. The flight path of the shuttle would span the entire width of the contiguous United States early in the morning, with a path that began in northern California, across the western U.S. to Texas, and then across the southern U.S. before a landing in Florida. Tragically, seven lives were lost as Columbia broke up over Texas.

Although the cause of the accident was ultimately identified as due to a debris strike on the left wing of the shuttle during the ascent phase after launch, in the early weeks after the accident the true cause was unknown and multiple avenues of investigation were pursued. One such avenue included the analysis of a digital photograph taken during the reentry by one of the authors (Goldie), which depicted an anomalous feature extending from (or toward) the path of Columbia as it crossed over northern California. After receiving a description of the image from the author, NASA dispatched a former shuttle astronaut to take possession of the digital camera and flash card on which the images had been captured, as well as a compact disk containing the images downloaded from the flash card. These items then were delivered to the FBI for the purpose of (1) authenticating the image as having originated from the specific camera and (2) analysis to determine the source of the anomaly, if possible.

The image authentication consisted of multiple parts. First, the files contained on the flash card were downloaded and compared to the image files contained on the compact disk to verify that the images were exact copies of one another, differing only in file names. Next, metadata associated with each image file was examined to determine if it was consistent with the questioned camera (NIKON COOLPIX Model 880), as well as with the exposure and focal length settings expected for the images in question. Likewise, the image size (in pixels) and output type (JPEG) were verified as being consistent with the questioned camera. It was likewise observed that the five Columbia images were originally assigned sequential file names when recorded on the flash card. Goldie reported that no subsequent images were acquired on the camera following the re-entry images, and test images captured in the laboratory using the questioned camera were found to be sequential, and continuous with the Columbia images. All of these factors were found to be consistent with an origin in the questioned camera.

Finally, an analysis of the anomalous image itself was conducted to identify artifacts consistent with malfunctioning detectors ("bad pixels") within the camera's CCD chip. A total of fifteen (15) such artifacts were identified in this analysis. All of these artifacts were likewise observed in the other four images of Columbia captured on February 1. Test images recorded with the questioned camera were found to contain all of the "bad pixels" seen in the February 1 images. For images the size of the Columbia images, the chance that any two images could share all fifteen anomalies at the same pixel locations through random chance was calculated to be less than one chance in 10-to-the-97th power.

A further examination was conducted to depict the presence of artifacts, which might indicate that the "anomalous" image was the product of intentional image manipulation. No such artifacts were observed, therefore it was determined that the Columbia images were authentic images recorded using the questioned camera.

#### Image Analysis, Image Authentication, Pixel Defects