Creating 3D Animations to Reconstruct Transportation Accidents: Illustrating Aviation Accidents Using Air Midwest Flight 5481 Takeoff Accident

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Abstract

The National Transportation Safety Board (NTSB) uses 3D animation to reconstruct and illustrate accident sequences so that the public can visualize and better understand the events leading up to an accident, the determination of probable cause, and the identification of safety issues. These animations factually and faithfully present the accident sequence based on measured, recorded, and calculated data. The purpose of this paper is to explain how the NTSB currently produces 3D animations by describing the process used for a specific accident.

1 Introduction

Accident investigations undertaken by the NTSB involve all modes of transportation and address highly dynamic and complex scenarios. Only after exhaustive collection and analysis of data does the NTSB reveal its probable cause determination and provide recommendations for improving transportation safety.

When the NTSB launches a "go team" on a major aviation accident investigation, experts in as many as 14 different specialties participate, collecting and documenting evidence at the accident scene. For an aviation accident, the data collected may include readouts from the cockpit voice recorder (CVR) and flight data recorder (FDR) (Fig. 1), radar data, wreckage scene measurements, eyewitness interviews, and vehicle records. NTSB staff analyze these data using a wide variety of aircraft performance and simulation codes to definitively establish the airplane's motion throughout the accident sequence. Once all data have been collected, integrated, and verified, the data are used to drive the animation, which can take three to six months to create. The animation is then presented to explain the accident at the public Board meeting.

2 Exposition

Using a takeoff accident as an example, we will discuss the methods used to create an aviation accident animation. On January 8, 2003, Air Midwest Flight 5481, a Beechcraft 1900D, crashed shortly after takeoff from runway 18R at Charlotte-Douglas International Airport, Charlotte, North Carolina (Fig. 2). Two flight crewmembers and nineteen passengers aboard the airplane were killed, and one person on the ground received minor injuries. Impact forces and a postcrash fire destroyed the airplane. The NTSB determined that the probable cause of this accident was the airplane's loss of pitch control during takeoff. The loss of pitch control resulted from the improper adjustment of the elevator control system compounded by the airplane's aft center of gravity, which was substantially aft of the certified aft limit. The accident was discussed at a public meeting where media, family members, and interested parties viewed the animations. (See http://www.ntsb.gov/events/2003/AM5481/default.htm.)

The animations had to be concise, simple, and detailed enough to be readily understood at the Board meeting. After working with investigators, engineers, and managers to storyboard the accident sequence of events, the animation team created two animations: one of the flight path, which was governed by data obtained during the investigation, and one of the elevator control system, which visually represented how the system components functioned in relation to one another. Animators used SoftImage XSI, AutoCAD, Adobe AfterEffects, Adobe Photoshop, and Adobe Premier to produce the animation, using the process described below.

Flight Path:

- Imported a commercially available Beechcraft 1900D model and modified it in XSI.
- Created the airport runway and hangar in XSI with documented and measured data using a CAD drawing and airport images as reference.
- Wrote an XSI script to read the CVR text file and MS Excel spreadsheet containing the FDR simulation-derived kinematics of the flight path as a function of time (Fig. 3).
- Set up multiple cameras to best capture the attitude deviations during takeoff from various angles.
- Synchronized digital time, airspeed, and altitude data with flight motion.
- Reviewed data accuracy against airplane attitude and motion to ensure accurate representation.
- Composited the data-driven flight path, digital time, altitude, and airspeed with selected cockpit communication to provide a context for the flight parameters (Fig. 4).

Elevator Control System:

- Studied the control system and used engineering perspective to illustrate the mechanical systems.
- Modeled the system with great detail using the manufacturer's engineering drawings and actual images (Figs. 5 and 6).
- Textured the components to produce a close representation to the actual system.
- Assembled the complex system and applied expressions to animate and ensure all parts functioned accordingly.
- Used appropriate effects and lighting to focus on essential parts of the cable system (Fig. 7).
- Used multiple camera settings to capture the relationship of the various components of the cable system (Fig. 8).
- Composited the rendered sequence with recorded narration.

3 Conclusion

The NTSB's 3D animation reconstructions are effective tools in helping the public visualize and understand the complex events that occur during transportation accidents. The process requires expertise in many areas, including investigation, engineering, animation, and diligent work to present the accident sequence. An important aspect in the development of these animations is the emphasis placed on portraying a completely factual reconstruction based on measured, recorded, and calculated data. In this way, these animations serve as part of the factual record of the NTSB's investigation.

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