Space Shuttle Model in wind tunnel tests.

along a specific trajectory. Boundary-layer-transition criteria used in the BLT Prediction Tool were developed from ground-based measurements to account for effects of both protuberances and cavities, and have been calibrated against flight data. Version 1 of this BLT prediction tool was developed in time for the first Return-to-Flight mission STS-114.

This work was done by Scott Berry, Tom Horvath, Ron Merski, Derek Liechty, Frank Greene, Karen Bibb, and Greg Buck of Langley Research Center; Harris Hamilton and Jim Weilmuenster, Contractors with Langley Research Center; Chuck Campbell, Stan Bouslog, Ben Kirk, Garry Bourland, Amy Cassady, and Brian Anderson of Johnson Space Center; Dan Reda and James Reuther of Ames Research Center; Gerry Kinder, Dennis Chao, Jay Hyatt, Maria Barnwell, and K. C. Wang of The Boeing Co.; and Steve Schneider of Purdue University. For more information, contact the Langley Innovative Partnerships office at (757) 864-4015. LAR-17337-1

2D/3D Synthetic Vision Navigation Display

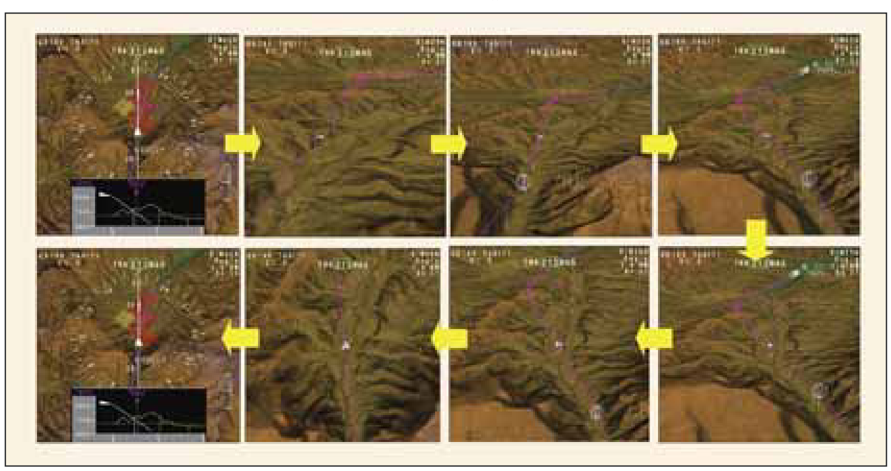
Langley Research Center, Hampton, Virginia

Flight-deck display software was designed and developed at NASA Langley Research Center to provide two-dimensional (2D) and three-dimensional (3D) terrain, obstacle, and flight-path perspectives on a single navigation display. The objective was to optimize the presentation of synthetic vision (SV) system technology that permits pilots to view multiple perspectives of flight-deck display symbology and 3D terrain information. Research was conducted to evaluate the efficacy of the concept. The concept has numerous unique implementation features that would permit enhanced operational concepts and efficiencies in both current and future aircraft.

One innovative feature, shown in the figure, was the ability of the flight crew to select among several modes that present a dynamic 3D perspective of aircraft within the flight environment. The study focus was to uncover the developments and benefits of using the 2D and 3D exocentric SV information with regard to primary flight displays (PFDs) and navigational displays (NDs) for reducing accidents and damage for commercial aircraft. The investigated technologies aim toward eliminating low visibility conditions as a causal factor in civil aircraft accidents, while replicating the operational benefits of clear-day flight operations, regardless of actual outside visibility conditions. The concepts also form the basis of revolutionary electronic flight bag applications that utilize these technological enhancements.

The results showed that SV on the PFD was pivotal for pilot use in terrain avoidance and situation awareness, while SV terrain on the 2D co-planar navigational display was not found to provide much benefit. However, pilots noted that the 3D exocentric display of synthetic terrain, with key implementation features, added significantly to flight-crew situation awareness and substantially enhanced the pilot's ability to detect and avoid controlled-flight-into-terrain situations.

Conclusions reached indicate that SV depicted on PFD is essential for terrain



Dynamic 3D Exocentric Navigation Display: Examples show several available display modes selected by pilots that dynamically present an immersed moving 3D perspective of the aircraft in relation to terrain, flight path, and aviation hazards (represented here as static images).

awareness. The situational awareness ratings for the SV PFD were largely due to the egocentric view that gave pilots an immersed sense of terrain around them. Pilot awareness and the capability for avoiding hazardous conditions were significantly enhanced with the addition of 3D exocentric navigation display modes that allowed for a greater field-of-regard to confirm the presence of hazards along their planned routing. The combination of SV primary flight and navigation display concepts allowed pilots to make the best and quickest decisions regarding safety of their aircraft.

This work was done by Lawrence J. Prinzel III, Lynda J. Kramer, J.J. Arthur III, and Randall E. Bailey of Langley Research Center and Jason L. Sweeters of NCI Information Systems, Inc. Further information is contained in a TSP (see page 1). LAR-17354

Automated Camera Array Fine Calibration

NASA's Jet Propulsion Laboratory, Pasadena, California

Using aerial imagery, the JPL FineCalibration (JPL FineCal) software automatically tunes a set of existing CAHVOR camera models for an array of cameras. The software finds matching features in the overlap region between images from adjacent cameras, and uses these features to refine the camera models. It is not necessary to take special imagery of a known target and no surveying is required.

JPL FineCal was developed for use with an aerial, persistent surveillance platform. Synchronized images from an array of cameras are captured and stitched together into a single, very high-resolution image that is projected onto an elevation map of the ground. A GUI (graphical user interface) tool allows the user to play a movie of any part of the imaged surface from any perspective.

JPL FineCal requires, as input, a set of CAHVOR camera models for the camera array. These models are typically developed on the ground using a calibration procedure requiring a known target at a short distance. JPL FineCal corrects the inaccuracy of the camera model extrinsic parameters resulting from the short target distance by using imagery, taken during flight, at an effective distance of infinity. It also makes small improvements to the intrinsic parameters.

JPL FineCal is an automated process that does not require the use of any special targets, and which may be applied during normal flight operations. Thus, it makes it simple to retune the camera models to correct for small misalignments that occur due to changes in aperture settings, vibration, or thermal changes.

This work was done by Daniel Clouse, Curtis Padgett, Adnan Ansar, and Yang Cheng of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).

The software used in this innovation is available for commercial licensing. Please contact Karina Edmonds of the California Institute of Technology at (626) 395-2322. Refer to NPO-45715.

Multichannel Networked Phasemeter Readout and Analysis

NASA's Jet Propulsion Laboratory, Pasadena, California

Netmeter software reads a data stream from up to 250 networked phasemeters, synchronizes the data, saves the reduced data to disk (after applying a low-pass filter), and provides a Web server interface for remote control. Unlike older phasemeter software that requires a special, real-time operating system, this program can run on any general-purpose computer. It needs about five percent of the CPU (central processing unit) to process 20 channels because it adds built-in data logging and network-based GUIs (graphical user interfaces) that are implemented in Scalable Vector Graphics (SVG).

Netmeter runs on Linux and Windows. It displays the instantaneous displacements measured by several phasemeters at a user-selectable rate, up to 1 kHz. The program monitors the measure and reference channel frequencies. For ease of use, levels of status in Netmeter are color coded: green for normal operation, yellow for network errors, and red for optical misalignment problems. Netmeter includes user-selectable filters up to 4 k samples, and user-selectable averaging windows (after filtering). Before filtering, the program saves raw data to disk using a burst-write technique.

This work was done by Shanti Rao of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).

This software is available for commercial licensing. Please contact Karina Edmonds of the California Institute of Technology at (626) 395-2322. Refer to NPO-45505.

MISR Instrument Data Visualization

NASA's Jet Propulsion Laboratory, Pasadena, California

The MISR Interactive eXplorer (MINX) software functions both as a general-purpose tool to visualize Multi-angle Imaging SpectroRadiometer (MISR) instrument data, and as a specialized tool to analyze properties of smoke, dust, and volcanic plumes. It includes high-level options to create map views of MISR orbit locations; scrollable, single-camera RGB (red-green-blue) images of MISR level 1B2 (L1B2) radiance data; and animations of the nine MISR camera images that provide a 3D perspective of the scenes that MISR has acquired.