Imagine two aircraft hurtling through turbulent air towards each other at hundreds of miles per hour. Now imagine lying on a cot, looking out of a small, rear-facing window in the belly of one of the planes and connecting a long telescopic boom and nozzle for transmitting gallons of highly flammable fuel to the refueling receptacle on the receiving plane, approximately 30 feet below. Few maneuvers in military aviation are more challenging than aerial refueling.

Developing the necessary skills to operate the boom safely and reliably requires practice. Acquiring the near real-world experience from high-fidelity simulators that recreate the environment with visual and auditory accuracy is a far less costly learning curve for new operators. A Christie simulation display is the visual backbone in the US Air Force’s Boom Operator Weapons System Trainer (BOWST) mission trainers.

Intensive training is critical to prepare the air refueling crew to ensure both the safety of the refueling and receiving aircraft, and to maximize mission success. Trainees fly 12 flights at 45 minutes each and fly 11 different sorties per aircraft with one additional repeat flight. The BOWST is a highly sophisticated mission trainer that recreates the environment of a KC-135 aircraft. The simulators provide realistic feedback, and sophisticated auditory and visual cues that effectively can reduce in-flight training time by up to 33 percent.

Christie was selected by the US Air Force Education and Training Command (AETC) and QuantaDyn Corporation to power its two Boom Operator Weapons System Trainer (BOWST) mission trainers, located in Altus AFB in Oklahoma.
designed and built by Christie, the images on the BOWST’s compound spherical screen are powered by 10 Christie Matrix Series DLP® projectors.

The need for high resolution and a seamless 220˚ x 55˚ field of view were two influencing factors in the decision to go with Christie’s Matrix Series projectors, as well as expertise with intricate simulation displays. Visual acuity is the key to displaying the details the boom operators need to accomplish their tasks. Influencers such as shadows, reflections, atmospheric conditions, reference points on the aircraft, parallax cues and the ability to discern hand signals from the pilot of the receiving aircraft all play an important role and must be clearly seen.

“The Christie Display solution combined with other high fidelity sub-systems on BOWST have exceeded the system requirements. At the completion of acceptance testing the BOWST finished Discrepancy Free based on the System Requirement Specification (SRS). This rarely happens on a system this complex,” explained Keith Seguin, Training System Program Manager, Trainer Development, USAF AETC.

Christie Twist™ provides built-in warping and blending for a single continuous image and Christie AutoCal™ automatic alignment provides effortless calibration and ease of operation and maintenance - a necessity for an arrayed display of 10 projectors.

Christie Twist is a powerful, easy-to-use option to manage arrayed projectors that allows users to display virtually any image, anywhere. Pixels can be mapped to any projection surface with proper geometry and perfect pixel to pixel alignment. Christie Twist provides the enhanced warping and expert blending required for arrayed projectors to operate as a single, uniform display.

Christie AutoCal is the automatic display system calibration that provides expert image display adjustment capabilities. A simple checkbox interface makes interaction user-friendly allowing users to re-calibrate both geometry and blending with unequalled accuracy. Christie AutoCal calibrates virtually any arrayed projection display, from flat to cylindrical to spherical, and adjusts it to its optimized viewing configuration to deliver the results you require.

The US Air Force uses an aerial refueling method that involves extending and lowering a telescopic metal boom from a tanker aircraft, KC-135. A boom operator works in a small, rear-facing compartment in the belly of the plane and uses hand controls to manipulate a pair of wing-like aerodynamic surfaces on the boom for navigation. An alternate method utilizes a boom drogue adapter to receive a refueling probe.

Operation of the boom during a refueling mission presents several challenges to the operator which must be reproduced in the simulation to provide consistent and effective training. The “boomer” must coordinate with pilots’ diverse skill levels and a variety of receiver aircraft in a wide range of environmental conditions while simultaneously processing visual, aural and physical cues to safely complete the refueling mission. In real life, 1,000 gallons of fuel is pumped per minute. How long that takes depends on the aircraft’s tank size.

The trainer-simulators replace earlier models that were more than twenty years old and lacked advanced sensory capabilities. Christie partnered with QuantaDyn Corporation, a privately held engineering firm specializing in high fidelity, immersive aerial refueling training devices. As the prime contractor, QuantaDyn is providing a turn-key solution to fulfill the mission requirements of the BOWST trainer.

“The visual system is a critical part of the trainer, contributing to the sense of realism for boom operators and pilots. Christie was the logical choice for both BOWST simulators, given their proven design expertise and top-quality projection systems that ensure a true-to-life experience for this high-fidelity training device,” said William Dunn, president of QuantaDyn Corporation. “Christie’s AutoCal and Christie Twist technologies also played a crucial role in our decision. They offer exceptional ease of set-up and operation to precisely control and align multiple edge-blended images seamlessly on the spherical screen.”

Designed and engineered for complex blended arrays where color matching and uniformity are critical, the Christie Matrix Series offers the highest resolution and delivers the highest consistent performance utilizing DLP® technology. They are the best solution for simulation environments where clarity of fast moving content is critical.
With proven reliability, high brightness, excellent color and brightness uniformity, and display control coupled with ease of use and low maintenance, the Christie Matrix Series exceeds requirements for projection display in simulation. As well, this proven digital technology is low maintenance with over 650,000 hours Mean Time Between Failure (MTBF).

A high-fidelity simulation solution is required to accurately model the aircraft dynamics for both the KC-135 tanker and the receiving aircraft. It must generate and display highly detailed real-time images of the refueling environment, produce simulated forces the boom operator senses on the controls and create appropriate aural cues associated with the aircraft and operation of the boom systems.

Possibly the most crucial aspect of the simulator is the presentation of accurate visual cues necessary to insert the boom nozzle into the receiver receptacle at a distance of approximately 30 feet. This requires the generation of very high resolution imagery that represents various lighting conditions across a wide field of view.

To accomplish this, Christie’s visual system projects real-time computer-generated imagery on a 12-foot radius compound screen with a 200° horizontal by 55° vertical field of view. Ten Christie Matrix Series projectors create that seamless view, synchronized through Christie AutoCal™ for automatic calibration and alignment.

The imagery for BOWST includes detailed graphical models of the boom, 22 receiver aircraft types, highly detailed receptacle areas, as well as key visual cues such as articulated control surfaces, lights antennae and pilots with the receiver aircraft. Weather conditions are another vital visual cue. They include specific time-of-day lighting specific to the selected training location and date and instructor-defined cloud patterns and turbulence.

The BOWST system provides simulation-based training that greatly exceeds previous capabilities. Through the use of high-fidelity modeling of dynamic, aural and visual effects, trainees gain experience that was previously only possible during actual training flights. Training in the BOWST will better prepare boom operators to maximize the effectiveness of training flights and better prepare them to successfully complete refueling missions.

Contact Christie
Contact us today at sales-us@christiedigital.com to find out how you can benefit from Christie projection and simulation solutions.