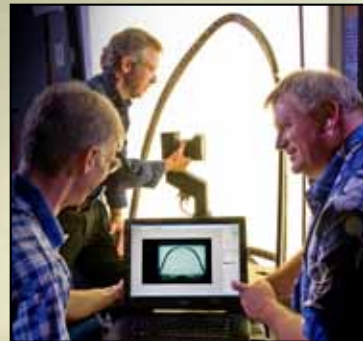


# Clear vision



Teamwork and a special camera help Boeing deliver flawless jet-fighter windshields

By Liz Lane and Mick Boroughs

Through the cockpit windshield of an F/A-18, the pilot spots an unidentified object that appears to be approaching the jet fighter.

The object moves in unison with the pilot's own maneuvers. Then, with the sun's rays at just the right angle, the pilot realizes it's not another aircraft but a tiny defect in the windshield.

It's a scenario no fighter pilot wants to experience, especially in combat.

"A distortion-free, defect-free optical windshield is absolutely essential to tactical aviation," said Dave Desmond, Boeing chief test pilot for Military Tactical Flight Operations.

A minor inclusion—a defect the size of a small dot—can catch a pilot's peripheral vision and be mistaken for an approaching

aircraft. But as a result of the work of a Boeing-led team and a Panoscan digital camera, windshield defects are being found on the ground, not by pilots in the air.

For Boeing engineers Mike Gleason and Matt Thomas, solving production riddles such as windshield defects is their mission. When the pair faced this recurring manufacturing issue on the F/A-18 production line in St. Louis, they began a collaborative quest to find a solution.

Polycarbonate, a tough thermoplastic, forms the structural backbone of jet windshields. Occasionally, small amounts of black carbon particulate, a byproduct of the fabrication process, end up in the polycarbonate. When that happens, black specks can litter the windshield.

To screen out defective windshields before installation, Boeing inspectors painstakingly eyeball every one but can overlook particles sized at 60 thousandths of an inch (0.1524 centimeters). During flight tests, these tiny flaws can show up when they are illuminated by sunlight streaming through the windshield. But the affected aircraft must then be returned to production for windshield replacement—a costly outcome that delays delivery and disrupts the supply chain.

Gleason and Thomas had an idea. Perhaps a shadow-based imaging tech-

nique could spot these windshield defects early on? They contacted Ron Bookout of Shared Services Group's Creative Services Photography team. Together, they began a two-year collaboration to transform and automate the F/A-18 windshield inspection process using a Panoscan digital camera that has the capability to capture a series of images in minute detail.

This effort resulted in a system with two patents pending. It features a portable light panel for windshield photography and a digital scanning technique to locate, size and flag all specks. It's a simple process. Workers put the windshield and camera into a fixture and run a three-minute scan to reveal any defects.

The process, which will save rework, expense and time, is the result of strong

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— Matt Thomas, Boeing engineer

**PHOTOS:** (Left) A new process being patented by Boeing more efficiently spots windshield defects on the F/A-18E Super Hornet, shown here, before the windshield is installed on the aircraft. U.S. NAVY (Inset) Creative Services photographer Ron Bookout (background) adjusts a Panoscan camera that will detect defects in the F/A-18 windshield while engineers Matt Thomas, left, and Mike Gleason review Digital Scan results. RICH RAU/BOEING

collaboration. Dan Pulcher, Doug Reed and Tony Roberts of Boeing Defense, Space & Security constructed the light panel; a team at Washington University in St. Louis tackled the image processing; and Bookout suggested the light-table solution and determined optimal camera settings to expedite photo generation.

"This is a fine example of what you can achieve using cross-disciplinary efforts," Thomas said. "We've never had a photographer take such an active role in developing a high-tech solution as Ron did."

Bookout's input earned him a signature spot, alongside other team members, on one of the patent applications.

"Partnerships can produce dramatic results," Bookout said. "This shows

what we can achieve when we put our heads together."

The goal is to integrate the screening system into the manufacturing process and screen every windshield before installation using the Panoscan system. This process also will be used for quality inspections at Boeing's St. Louis plant.

The results have been promising. "We just aren't seeing the defects we used to see before Panoscan," Desmond said. ■

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