The JHMCS Operational Flight Program Is Usable on Three Tactical Aircraft

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CrossTalk

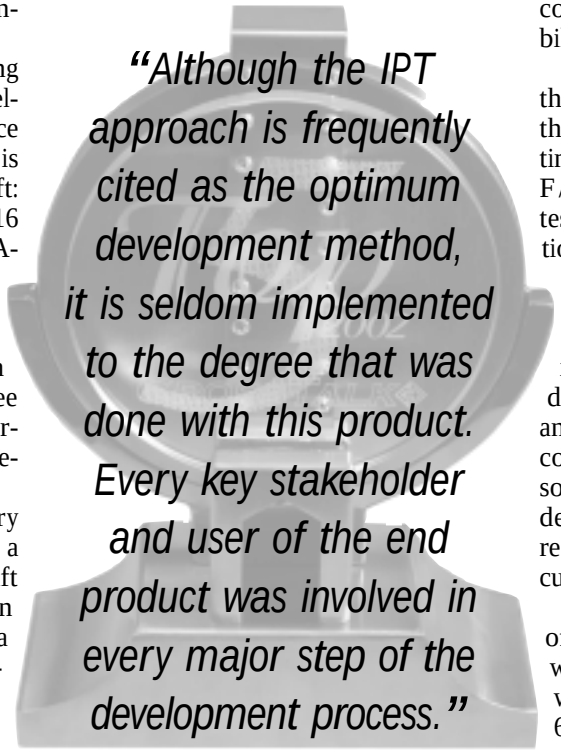
To keep a complex system on cost, on schedule, and at zero delivered defects is no small task. But to do it with one product that can be applied to three different platforms? That was the goal achieved by the Joint Helmet Mounted Cueing System, a high-tech pilot helmet that displays aircraft performance and weapons data on the pilot's visor. It is designed for use by three tactical aircraft, each employing different display formats.

Imagine one product that works across three platforms, contains zero defects, and was developed by several integrated organizations. Got it? Now, add to that the product's ability to enhance performance by way of intuitive training and ease of use and the possibility of future use in fields such as medicine and entertainment. And that's just for starters.

The Joint Helmet Mounted Cueing System (JHMCS) is a high-tech pilot helmet that displays aircraft performance and weapons data on the pilot's visor. It is designed for use by three tactical aircraft: the U.S. Air Force's F-15 Eagle and F-16 Fighting Falcon, and the U.S. Navy's F/A-18 Hornet. Each of these platforms employs different display formats. The goal of the JHMCS Operational Flight Program (OFP) was to be a common system – one product usable by three platforms that still provides for each aircrafts' unique weapons and sensor integration needs.

The JHMCS adds a revolutionary capability to tactical aircraft: Previously, a pilot had to maneuver 25 tons of aircraft in order to bring weapons to bear on an air or ground target. With the JHMCS, a pilot can aim weapons and sensors simply by turning his/her head, completely eliminating the need to point the entire aircraft. The pilot receives feedback – displayed on the visor – of sensors and weapons, including tracked targets, weapons launch and cueing parameters, and aircraft performance information such as airspeed and altitude. Key aircraft performance and tactical data are continuously available regardless of where the pilot looks, providing a significant increase in situational awareness; pilots do not need to divert their attention back to the cockpit displays to obtain needed data – it is always available wherever they look.

That the organizations working on the JHMCS were spread across countries, states, and time zones coupled with creating one product that had zero defects and was rated as highly effective by both F-15 and F/A-18 pilots are but a few of the many reasons that the JHMCS project was chosen as one of the 2002 U.S. Government's Top 5 Quality Software Projects.



Project Need and History

No other system is quite like the JHMCS, according to Boeing/JHMCS Deputy Program Manager Phil King. The closest helmet-mounted system is in the Army's Apache Helicopter. But the applications of the two are very different: the Apache is for low-altitude, heavy terrain nighttime flying. The JHMCS is specifically designed for high-performance tactical aircraft.

"It was originally conceived as a means of putting a heads-up display on the pilot's head," says the Air Force's JHMCS Chief Engineer Patrick Grebinski. "The most driving need for developing the JHMCS was the need to visually aim the AIM-9X short-range high off-boresight missile during close-in 'dogfight' maneuvers," says Grebinski. "The AIM-9X provides a significant increase in air-to-air capability, and a helmet display like JHMCS was the only way the pilots could take full advantage of all the capability provided by this weapon."

OFP-6.1 is the operating software for the JHMCS and is a software upgrade to the previous version, OFP-5.0. At the time of the software project, the F-15 and F/A-18 had concluded developmental testing and were midway through operational testing; the F-16 was just beginning its integration development. As a result, OFP-6.1 had two objectives: to resolve potential F-16 integration issues, and to correct problems found during F-15 and F/A-18 developmental and operational testing, while maintaining compatibility with OFP-5.0 flight-tested software. "Corrections for 20 anomalies, deficiencies, and improvements were required in OFP-6.1," says U.S. Air Force customer Lt. Col. Alton J. Scott.

The OFP was delivered in the form of quality assurance-stamped discs, along with a Version Description Document, which documented the changes in OFP-6.1. Interface Change Requests were used during development to document all changes to the JHMCS aircraft interface. These are currently being incorporated into the JHMCS Interface Control Document, a body of text that defines all pertinent interfaces to the subsystem, including the digital signals passed between the JHMCS unit and the host platform.

OFP-6.1 contains 44.5 thousand (K) core lines of code (CLOC), 23.5K CLOC to communicate with the line-of-sight module, and 20K CLOC to communicate with the symbol generator. The OFP resides in the JHMCS electronics unit, which is a remote terminal on the Mil-Std 1553 aircraft avionics multiplex bus.

Approach to Development

"What is … equally noteworthy is the IPT [Integrated Product Team] approach to development of this software," says Scott. "Although the IPT approach is frequently cited as the optimum development environment, it is seldom implemented to the degree that was done with this product. Every key stakeholder and user of the end product was involved in every major step of the development process."

The IPT consists of government and contractor technical experts from each of the three aircraft, plus the Joint Program Office, Boeing (JHMCS contractor), Vision Systems International (JHMCS developer), and Elbit Systems Ltd of Israel (JHMCS software developer). The IPT managed the development of the JHMCS electronics unit OFP. All IPT members attended and participated in requirements definition, design reviews, and testing of pre-release OFP versions. During development, the F-15 and F/A-18 were the leading platforms; the F-16 trailed the other two by a year. The timing was such that F-15 and F/A-18 Initial Operational Test and Evaluation was being completed as F-16 integration was beginning. Initial testing was completed utilizing OFP-5.0 software. Both versions were initially developed by Elbit, which is certified at Software Engineering Institute Capability Maturity Model Level 3[1]. A systems requirements review was held at the project's outset to capture requirements from all three platforms (F-15, F-16, and F/A-18).

Generating budget estimates and prioritizing individual *wish-list* requirements helped establish an affordable list of project requirements, according to King. Regularly held joint working sessions helped resolve issues and disputes. The IPT participated in all design reviews to ensure that needs were being met. A pre-release version was issued to the three platforms for testing in their facilities. This step enabled any errors to be identified and corrected before final release. During this phase, two errors were found and corrected before final delivery.

The end user environment is an operational tactical aircraft and contains its own internal operating system. The OFP processes commands from the host platform mission computer, computes helmet line-of-sight, and generates and renders all display formats. All processing is performed in real-time due to the subsystem's in-flight mission application and human factors involved.

Standard commercial software development tools were used during development, including Emacs, GNU, VxWorks 5.3, and Tornado 1.01 for coding, compiling, and debugging, and MS Office tools for documentation, metrics, design items, etc. Testing, including final verification and validation, was performed in Boeing's Avionics Integration Center, which contains special labs designed to trap, filter, and record various input/output signals and ensure proper integration with the end-user weapons systems.

The Joint Helmet Mounted Cueing System Display Unit

The JHMCS program met the simultaneous needs of all three aircraft. Because the F-15, F-16, and F/A-18 are also sold internationally, a growing number of international users further complicated the schedules of each aircraft program. Despite these demands, the development process ensured rigid adherence to cost, schedule, and quality requirements through the IPT process, engineering testing, and pre-release testing.

Meeting and Exceeding Expectations

OFP-6.1 is the final engineering event of the JHMCS and had to be kept on cost (to avoid an overrun), on schedule (to meet program need requirements), and developed within existing budget resources. It was delivered one month past the original date to resolve a requirements issue among the platforms that occurred after critical design review. Once final requirements were established, the schedule was revised and all remaining goals met the new schedule. The final version passed the final series of tests and OFP-6.1 was delivered to the three end-user platforms.

"To meet the diverse requirements of three platforms with a single OFP is itself a major accomplishment," says Scott. "To do so and remain on schedule – the only delay was due to a customer requirements issue – and to deliver software with no deficiencies may be an exceptional event in the history of special purpose, real-time, tactical equipment software of this level of complexity." To keep such a complex and challenging system like the JHMCS on schedule, under cost, and at zero delivered defects, while being able to meet the many requirements and demands is a significant accomplishment. It is why the JHMCS is a Top 5 award winner.◆

Note

1. The Elbit software team that developed JHMCS was one of four groups specifically reviewed by SEI when ESL achieved Level 3 certification.

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