Refueling innovation

View with 3D glasses
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Inspired by in-house technologies, Rockwell Collins employees took a collaborative approach to design cost-effective solutions for the KC-46 tanker.

Military aircraft that perform attack, reconnaissance and air defense missions are known for speed, maneuverability, superior weapons systems and stealth. Yet, without the tanker’s aerial refueling capabilities, these aircraft wouldn’t have the military might to respond quickly to a conflict or crisis anywhere in the world.

When Rockwell Collins employees constructed proposals for Boeing’s new KC-46 tanker for the United States Air Force, they were intent on modernizing aerial refueling operations. Technology and geopolitics have changed a lot since the Cold War era when the current tanker — the KC-135 — was initially deployed. After looking at requirements and working with internal experts, engineers envisioned high-tech and cost-effective solutions for the new tanker that would benefit all U.S. forces for decades to come.

“The tanker’s primary mission is refueling,” explained Keane as he flipped through an album of photos portraying refueling operations on a KC-135. “It’s a difficult job that requires a clear view and accurate depth cues in all conditions.”

In the photos, Keane showed how a KC-135 boom operator currently conducts this aerial ballet while lying face down, peering out a small window to guide the boom into the receiving aircraft. He explained that with the RVS, refueling will become more like a video game — an operator will watch a large stereoscopic 3D display to connect the boom to the receiving aircraft.

“It’s critical to have those 3D depth cues so operators can guide the boom into the receptacle,” said Gladys Yanez, a systems engineer on Keane’s team, working on the RVS in Cedar Rapids, Iowa.

“We’re using proven technology to develop an imaging solution that has never been done before,” said Yanez. “That’s what is exciting.”
Evolved from a robot

Many times, inspiration begins by taking technology already available and adapting it to the challenge at hand. This is exactly what happened with the RVS.

During the early stages of the proposal, the team contacted employees in Carlsbad, Calif., and Warrenton, Va., who worked on optics for the Mars rovers and unmanned aerial vehicles, respectively. They also reached out to employees in Portland, Ore., hoping to draw upon their experience with head-up displays, along with the Head Down Display Center (HDDC) in Cedar Rapids.

“A remotely-operated bomb-disposal robot in the HDDC sparked the idea for the RVS proposal,” said Yanez, who has been at Rockwell Collins for four years and is quickly becoming an expert on imaging technology. “The stereoscopic 3D display used for the robot helped us develop a solution that would work for the RVS. It was as if we started with a puzzle we had already put together, and then thought about how we could adapt those pieces to meet a new customer need.”

At the same time, the RVS team evaluated the Air Force’s requirements to design a long-term cost-effective solution. One of these requirements was ruggedization — a process that distinguishes military 3D technology from that used commercially in products like televisions.

“Consumer commercial technology couldn’t withstand the environmental factors the technology on the tanker will endure under normal operating conditions,” explained Yanez, pointing to a consumer digital camera as an example. “If you put your camera in the freezer — temperatures that the RVS sensors will routinely experience — it probably won’t work anymore. So we ruggedized each piece of the RVS, which was challenging, but something Rockwell Collins knows how to do well.”

Collaborative relationships

Along with the RVS, Rockwell Collins is providing the large-format cockpit display system, tactical situational awareness system, autopilot flight director system, military and commercial navigation sensors, military and commercial communication radios, the signal data converter network, onboard maintenance system and data transfer unit.

To develop these solutions, more than 200 Rockwell Collins engineers will be assigned to the KC-46 program. And while the overall program is managed by Government Systems, it includes engineers from other areas of our company.

Lisa Steffen, formerly the Commercial Systems principal engineering manager for the display program for the Boeing 787 Dreamliner, led the proposal for the KC-46 boom operators will use the Remote Vision System — instead of a small window — to view the boom and receiving aircraft. The system, provided by Rockwell Collins, includes cutting-edge sensors, a graphics subsystem, stereoscopic 3D displays and 2D displays (above). The stereoscopic 3D displays provide the boom operators with enhanced depth perception.
large-format cockpit display system on the KC-46. According to Steffen, Rockwell Collins submitted a proposal so that the physical displays and features on the new tanker would mirror the Dreamliner.

“The wide displays on the 787 are well received by pilots, and our proposal will provide some of the same features on the tanker,” explained Steffen. “We’ve built a collaborative relationship with Boeing, from their engineers to their leadership. That has led to a lot of strong working relationships.”

Integrating information
Of course, as a military platform, the KC-46 has unique requirements for tactical information. That’s where Rockwell Collins’ datalink integration team comes in. For the past four years, a team in Richardson, Texas, has been developing datalink and situational awareness technology for multiple programs, including the Tactical Situational Awareness System (TSAS) processor and display for the KC-46.

“Our team has experience with multiple tactical datalinks and has grown in size to support this and other future datalink programs,” explained Technical Project Manager Kimberly Frank, whose team will include more than 35 people from Richardson at the peak of the program. “With TSAS, we’re providing a new level of capability with improved situational awareness that helps tanker pilots identify other aircraft and threats.”

The KC-46 program brings some additional challenges, due to the amount of information from multiple sources that must be correlated and displayed to the tanker crew.
“We’re experts at being able to display that information in a way that can improve pilots’ situational awareness without overwhelming them,” said Josh Brinkley, a senior software engineer behind the TSAS software built on the Rockwell Collins OpenEdge™ product line. “As a team, we analyzed the requirements and architected a solution to provide a tactical situational awareness system that minimizes aircrew workload as well as enables tanker crews to make more informed decisions.”

During the proposal phase, the team discussed how to meet requirements while also providing the best technical solutions for the lowest cost. Employees who had previously worked on digital mapping solutions, datalinks, military radios and OpenEdge software were consulted. These employees provided best practices for receiving, processing and displaying information. Brinkley’s team also turned to the Advanced Technology Center (ATC) for innovative technology when an aircraft needs to be rerouted in flight due to pop-up tactical threats such as surface-to-air missiles or hostile aircraft.

Dr. Ryan Young, a principal systems engineer in ATC, has been leading an internal research team to develop Airborne E*, a technology that will be used on KC-46 tankers to automate the threat assessment and avoidance tasks.

“Currently, when pilots determine a reroute is needed, they also need to decide what maneuver should be performed to safely avoid pop-up threats as well as terrain and surrounding traffic,” explained Young. “Our automatic rerouting technology shows how technology developed through internal research helps us win programs.”

A new generation

At the end of February, soon after the U.S. Air Force announced the selection of the Boeing Company to provide the KC-46 tanker, Brinkley received several instant messages from his fellow engineers.

Many employees had followed the tanker’s decade-long competition. Weeks before the ink dried on our company’s contracts, they were eager to start work on TSAS solutions that would help the warfighter — today and in the future.

“The OpenEdge software architecture in TSAS allows the customer a lot of flexibility and capability for growth potential,” explained Brinkley. “It’s very easy to add new capabilities to TSAS; if a customer updates or adds new hardware in the future, the application can be easily modified based on the modular design of the OpenEdge software.”

Already, the datalink integration team is testing the software on new hardware platforms, including smartphones and tablet computers that run the Android™ operating system.

“The scalability of the OpenEdge architecture is really what makes TSAS such a cutting-edge setup for military applications,” explained Frank. “It’s possible for a soldier on the ground or a sailor on a ship with a smartphone to see the same tactical picture as the pilot in the tanker.”

Asked about the future, Brinkley responds with an answer typical of employees on the KC-46 tanker program these days.

“We’re ready to execute on a program we’ve been waiting years for,” he said. “It’s a very exciting time.”

By Katie Shatzer and Crystal Hardinger