US Army Working with NATO on DVE and Next Gen Rotorcraft

Several recent NATO study groups have been focused on rotorcraft with promising results and have begun gathering momentum.

By Andrew Drwiega

Through the North Atlantic Treaty Organization (NATO), the vertical flight technical communities in the allied nations are cooperating on several issues related to vertical flight. In addition to successes through cooperative flight testing in degraded visual environments (DVE), a NATO study group is now starting to look at what Next Generation Rotorcraft Capabilities — à la Future Vertical Lift (FVL) — would mean within a NATO context.

DVE

A NATO program aimed at enabling helicopter operations in DVE has been in the planning since 2012, when discussions about how to solve the serious problems caused by DVE began within NATO’s Joint Capability Group Vertical Lift. (JCG-VL is within the NATO Army Armaments Group, which in turn is part of NATO’s Defence Investment Division.)

Layne Merritt, chief engineer at the US Army’s Aviation Development Directorate (ADD), part of the Aviation and Missile Research, Development and Engineering Center (AMRDEC) recalled how the DVE study was initiated: “We had just finished a study dealing with aircraft survivability. One of the [Pentagon’s] major conclusions on survivability was that we were losing more helicopters and people due to controlled flight into terrain (CFIT) than to hostile actions.”

The US Department of Defense (DoD) was considering buying a civil navigation system that had built-in terrain awareness, but when the market was examined, most of these systems were not appropriate for military rotorcraft in their operating environment.

Merritt noted that most of the existing systems were designed for airplanes, and their database software was not designed to function below 500 ft (150 m) — exactly the area that was of concern to the rotorcraft community.

So the US Army set out to study the causes of the accidents leading to the loss of a helicopter, which quickly revealed that crew losing situational awareness — particularly in difficult operating conditions — was a major issue that either ended in loss of control of the aircraft or CFIT.

“While this had been addressed within Aeronautical Design Standard 33 (ADS-33), which is for aircraft handling qualities, the discussion within the NATO group in February 2012 led us to propose activity that would result in flight trials of new systems." The intent was to bring together a variety of systems from several nations that could be tested together in similar conditions on different ranges. “We recognized that not only dust, but also moisture-related environments were a challenge.”
The proposal to establish a NATO industrial advisory group (NIAG) study for helicopter operations in DVE was approved. It ran for two years as NIAG Study Group SG-167 and focused on low-level flight, which was the most immediate problem.

The US and other NATO nations had been independently conducting research into DVE and were thinking about acquisition programs. The focus of the flight tests and the results of NIAG SG-167 was to collectively conduct trials to inform acquisition officials about how they might address the DVE challenge for rotorcraft fleets. “We weren’t there to develop a DVE system but rather to explore the technologies and determine how effective the developmental systems were,” explained Merritt.

Merritt said that the trials were specific and did not address the whole profile of helicopter operations: “We initially focused on takeoff and landing, as well as low speed maneuvering — or hover taxi — in a landing zone. We were not addressing a full mission profile. Flying at 140 kt [260 km/h] is a whole different game than maneuvering to land and at takeoff. However, we still thought that this might be a combat enabler — to all crews to use these types of DVE systems to increase their use of environmental conditions as concealment.”

Trials were designed to test three complementary approaches to overcoming DVE issues: the uses of sensors, cueing and flight control technologies. According to Maj. Joe S. Minor, program manager and experimental test pilot with DVE-M AMRDEC, “advanced flight controls and cueing may reduce an aircraft’s reliance on sensors in some situations. The testers were also aware that a comprehensive solution meant for all types of DVEs will likely involve trade-offs.”

In terms of setting up actual flight trials, five nations decided to commit to attending and bringing systems. The US, Canada, Germany, the UK and Switzerland all opted into the trials that would take place at the Yuma Proving Ground in Arizona in September 2016, followed by further trials in Germany and Switzerland in February 2017. This eventually became known as the NATO DVE Flight Trials and associated NATO joint studies.

Yuma was the obvious location to conduct dust (brown out) trials, while the rain, fog and cloud trials would be run from Manching airbase in Germany. Snow (white out) trials would be conducted from Alpnach in Switzerland, with aircraft flying up to a mountain test range as there was no snow around the airfield. “As it turned out, the weather in both European locations was historically nice,” noted Merritt. Testing would be conducted for a week in each location.

“The plan was that everyone needed to bring a full helicopter-mounted system — although that wasn’t possible in some cases,” said Merritt. Eventually, three aircraft were fielded to conduct the trials: an American AMRDEC EH-60L Black Hawk, a Swiss Air Force EC635 (aka H135M) and a German Aerospace Center (DLR) EC135. “We thought about having one aircraft and switching around sensor packages but there was too much risk and there would likely have been installation issues which would have delayed the trials — so if it wasn’t mounted on a helicopter, it was only ground tested,” stated Merritt.

Test pilots from each of the nations flew qualitative evaluations in each other’s aircraft: DLR’s EC135 — which was fitted out with a dynamic transition-to-hover guidance system — against a raised obstacle in the dropping zone; the Swiss EC635 equipped with the Sferion enroute guidance and landing zone symbology; and the American EH-60L equipped with a millimeter wave radar, a FLIR and a lidar as well as advanced flight controls and custom symbology. In all, 22 different industries contributed technology to the flight trials and studies.

All test pilots were very experienced, with non-US pilots averaging 22 years of military service. “They all had accumulated flight hours ranging from 2,000 to 7,800, with 1,500 hours of glass cockpit experience,” said US Army Maj. Paul Flanigen, speaking after the trials had been completed. Flanigen is the assistant program manager for AMRDEC’s DVE Mitigation Program.

According to Merritt, all of the pilots and engineers in the testing community immediately understood another. “It is almost like they went to the same school. It turned out that they all had the same vocabulary, which meant that through a series of meetings, it was quickly decided how the flight test would be executed.”

Safety remained a dominant issue and, while the helicopters were deliberately set to enter difficult conditions including low...
A Swiss Air Force EC635 was fitted with the Airbus Defence & Space Sferion system for pilot assistance in white-out conditions. (Swiss VBS/DDPS)

cloud, they still had the ability to transition to full instrument flight rules (IFR) and fly back to the ground.

Maj. Minor reported that “all of the systems demonstrated performed well in certain areas and could use improvements in other areas. By looking at several different systems, each team could find ways to improve their own system, and improve safety and capability across the NATO team.”

A separate NIAG Study Group, SG-193, “Airworthiness Qualification of the DVE Systems & Field Trial” has also benefited from the trials and data regarding the suitability and airworthiness of DVE systems, said Merritt. “There are no DVE airworthiness standards published, so we wanted to find out what standards industry thought would be appropriate. The NIAG group has been working with the data to come out of the flight trials and is now nearly ready to publish their finding.”

One conclusion was that sensors alone currently are not sufficient to provide a complete DVE solution through their limited fields of view and predictability of performance. Flight control systems are required to support this flight, and a cueing system that can provide the pilot with warnings and flight guidance is also appropriate for such flying.

Merritt pointed out that it is normal for technology to be ahead of policy and regulations, and that the aim of the trials was to effectively inform and support decision makers in the acquisition community, something that is particularly relevant to the current Joint Multi-Role (JMR) Technology Demonstrations — and the analysis of mission system requirements — that precede the Future Vertical Lift (FVL) program.

Following the completion of the three trials, the JCG-VL working group voted to extend its work for another year to allow the finalization of full reports. While NATO actually contributed €1M (about $1.1M) toward this study over three years — something that is rare — there is no specific NATO program to implement the results across its members.

The US Army already has a large science and technology (S&T) program for DVE, and sponsored the US-based Yuma flight trials. While AMRDEC’s ADD is the program lead, work on DVE is also conducted by the US Army Research Laboratory, the Army Aeromedical Research Laboratory and the Army Communications-Electronics Research, Development and Engineering Center (CERDEC).

**Next Generation Rotorcraft Capability**

In addition to the joint NATO work on DVE, the JCG-VL has initiated a multi-organizational team of experts (TOE) to investigate what will be required to develop the next generation of rotorcraft.

In July 2016, the first meeting of the Next Generation Rotorcraft Capability (NGRC) Team of Experts (NGRC TOE) was held at the Joint Air Power Competence Centre (JAPCC) in Kalkar, in westernmost Germany. The NGRC TOE is working to identify and examine developing technologies for rotorcraft, as well as looking to their force structure and how they may be employed. The NGRC TOE is a two-year program that is overseen by the NATO JCG-VL.

The TOE also involved the Allied Command Transformation-Staff Element Europe (ACT-SEE), NATO Science and Technology Organization (STO), the NIAG, and JAPCC.

ADD’s Dan Bailey, program director for the JMR Technology Demonstrations and also head of the NGRC TOE, noted recently that a change to next generation rotorcraft was necessary because “our ability to upgrade efficiently [legacy platforms] has gone down.” Most current US and NATO military rotorcraft were first flown in the 1960s and 70s.

The objective of the program is “to identify, analyze, assess and document advanced rotorcraft technologies, force operational concepts, force development program, force structure implications and legacy system integration and interoperability.”

Two specific areas were identified for industry partner participation at a further Conference of National Armaments Directors (CNAD) in December 2016. Among the proposals for study open to partner participation in 2017 were two that specifically involved rotorcraft. The first was the aforementioned “Airworthiness Certification of Rotorcraft Degraded Visual Environment Systems (DVES) and Flight Trials (Phases 3 and 4)” — Study Group 193.
Also initiated was “Concepts for Operations and Equipment for Next Generation Vertical Lift Operations” (or “Next Generation Rotorcraft Capability”) — Study Group 219. The one-year NGRC study group was established to enable industry to support the JCG-VL NGRC Team of Experts. It is the opportunity for industry — from across the 28 NATO member nations and the 22 Partnership for Peace (PfP) countries — to collaborate on a pre-competitive basis to develop a summary of technology-enabled capabilities that could be ready in time. The industry collaboration and the industry-authored compendium of candidate rotorcraft technologies and maturation roadmaps will be of great value to the TOE.

This SG-219 opportunity for industry coordination to deliver a product to the TOE and the NATO national governments is not normally available in the US defense community, where the military services act as the integrator and assemble the lists of technologies.

The NATO JCG-VL works alongside the Applied Vehicle Technology (AVT) Panel (which is under STO), the Helicopter Inter-Service Working Group (which is under the Military Committee) and NIAG Study Groups 167, 193 and 219, all of which are driving an understanding of future requirements.

Common Interest
NATO and member nations are jointly looking at areas of common interest, with additional efforts planned for the future.

Two NATO study groups have enhanced cooperation within the vertical flight technical communities of the NATO member nations and advanced understanding of operations in degraded visual environments.

The JMR Technology Demonstrations and the FVL program have instigated international interest. The Next Gen Rotorcraft Capability Study will be closely watching these American efforts as inputs to understating requirements for NATO member countries and partners.

About the Author
Andrew S. Drwiega is the Director/Editor of DefenceWorX Ltd, a UK-based defense consulting group. He was previously the international bureau chief of Rotor & Wing magazine.