PARADIGM *Shift*

BY WAYNE ROSENKRANS

After the recent A320 bird strike and ditching, expectations soared for avian radar to warn airline pilots of real-time hazards.

When the U.S. National Transportation Safety Board (NTSB) convenes a public hearing in mid-2009 on a few aspects of the Jan. 15, 2009, ditching of a US Airways Airbus A320 into the Hudson River, attention to digital avian radar likely will be more intense than at any time since 2006. That year, a proposal for civilian-military and public-private collaboration — the *North American Bird Strike Advisory System: Strategic Plan* (NABSAS) prepared by the U.S. Federal Aviation Administration (FAA), the U.S. Air Force and Transport Canada[1]— was shelved, and the FAA decided to limit most subsequent avian radar research to performance assessments.

Aspiring to deploy a network of airport avian radars and real-time bird hazard alerting within 10 years, the NABSAS addressed issues that may resurface in the current NTSB investigation. But the plan may have been most prescient in expecting mitigation of bird strike risk to be impeded primarily by human, not avian, factors.

Preliminary NTSB factual information said that Flight 1549 was "ditched into the Hudson River shortly after the aircraft struck Canada geese, resulting in an immediate loss of thrust in both engines." Two people were seriously injured among the 155 passengers and crew. One of four focus areas planned

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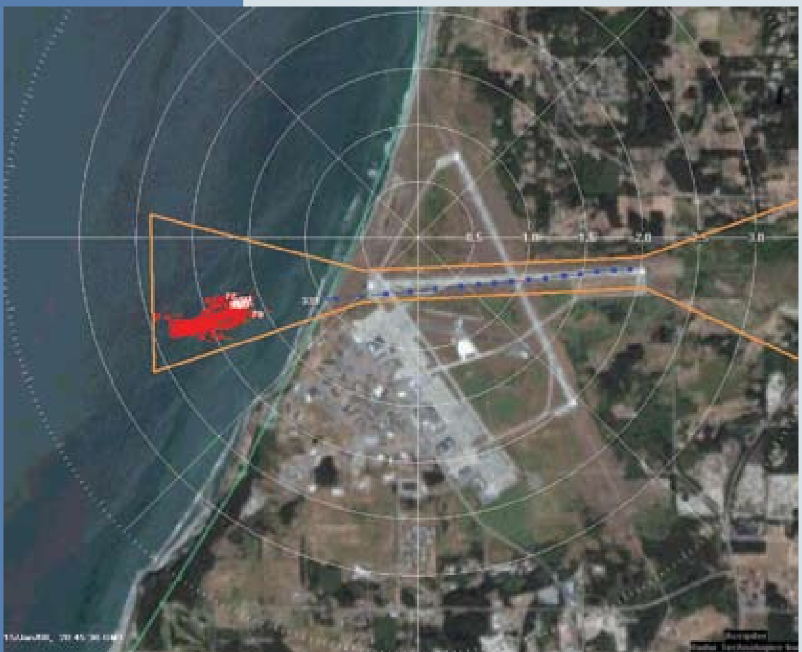

Avian radar captures a near-miss event at Naval Air Station Whidbey Island, Washington, U.S.

for the hearing is "new and developing technologies for detection of large groups of birds and procedures to avoid conflicts with birds in the general vicinity of airports," the NTSB said.

NTSB member Robert Sumwalt on Feb. 24 told a congressional committee hearing that the first officer, the pilot flying, "spotted a group of dark birds slightly to the right of the flight path" and an instant later, about 1.5 minutes after takeoff, the flock filled the windscreen and multiple bird strikes occurred at an altitude of about 2,750 ft. The captain took control of the airplane, and the aircraft touched down about 3.5 minutes after the bird strikes.

Margaret Gilligan, FAA associate administrator for aviation safety, characterized avian radar at the hearing as a limited technological solution so far. "Bird detection radar may have the most promise as tools to help airport operators manage their wildlife control programs," Gilligan said. "However, as many airports routinely have birds in the area, we do not yet know if this system would be capable of providing alerts that would be operationally suitable for making specific time-critical decisions on landing or takeoff."

In The Spotlight

The avian radar systems intended for civil or military airport use typically are designed from commercial off-the-shelf marine X-band, S-band or combined radar sensors; advanced digital radar signal processors; personal computers programmed with proprietary bird-tracking algorithms that process target data; geographical information system (GIS) mapping software; and network communication. Some are on mobile platforms, others have been installed in airport buildings with roof-mounted antennas.

In the wake of the Flight 1549 accident, some have asked the FAA and its Center of Excellence for Airport Technology (CEAT) at the University of Illinois–Urbana Champaign to explain what has impeded the development of real-time alerting for air traffic control (ATC) and pilots (see "Other Countermeasures," p. 40). The possible timing and relative safety of envisioned alerts to pilots have yet to be determined, however, in the context of the maneuverability limitations of transport jets, visibility restrictions from the flight deck and air traffic conflicts. Nevertheless, Edwin Herricks, a professor at the university and principal investigator on avian radar use at civil airports for CEAT, says that because of this accident "the paradigm has shifted — we are no longer working in obscurity" given new public expectations.

"Now that we have radars deployed and collecting data, the CEAT team is working on a group of reports," Herricks said. "One report on the deployment of avian radars hopefully will help people who are contemplating using them to have a realistic sense of what an avian radar can do. We then will produce a shorter technical publication on mapping clutter — the electronic background noise and the radar returns from buildings, trees, etc. Our third report will talk about our nearly two years of experience with three radar systems at Seattle-Tacoma [International Airport, Washington, U.S.] and discuss the operational applications and their utility from the perspective of a user … to promote realistic expectations rather than unrealistic ones." During the deployment phase, the FAA

Other Countermeasures

The Air Line Pilots Association, International (ALPA) in February expressed optimism about the safety contributions of digital avian radar and published a white paper titled "Wildlife Hazard Mitigation Strategies for Pilots."

"Being able to find birds, track them and project their position with quality radar is of great interest to us," said Rory Kay, a captain and ALPA's executive air safety chairman. "Pilots not only have to know the projected direction of flight but know at what altitude the birds are flying. If [the birds] are at 1,000 ft and 5 nm [9 km] from the airport, the birds are not an issue. If I can be made aware [of birds] I can pick a different runway to use for departure or arrival, or I can simply delay my departure or arrival while a clearly visible, large flight of birds transits the area. That would not always work, so ongoing wildlife hazard mitigation programs at each airport are important."

John Prater, a captain and president of ALPA, added, "What we are really looking for is separate air traffic control displays so they have a radar that is specifically tuned and pointing at the local area, a small radius for tracking and … a sophisticated communication system … so that if birds are being tracked, that information can be passed via radio to the pilots."

Airline training on flight deck countermeasures, and quickly funding and implementing the next generation air transportation system, NextGen, also were cited as important ways to reduce bird strike accident risk. "Some airlines provide a checklist that covers what to do following a bird strike, but ALPA is unaware of any airline that provides wildlife-avoidance training," Prater said. "We would suggest that wildlife-avoidance techniques and guidance, such as that included in the [U.S. Federal Aviation Administration] *Aeronautical Information Manual*, be provided in airline flight operations manuals, training materials and other company guidance for flight crews. … On arrivals and departures, [airline pilots] are held sometimes for hundreds of miles at low level because of the inadequacy of the ATC system. So NextGen is about capacity at airports, keeping us higher longer, saving fuel, reducing carbon emissions and certainly keeping us and the birds out of each other's path."

The ALPA white paper calls for high alertness to bird and mammal activity reports while taxiing; a final check of the runway for wildlife before commencing takeoff; waiting for wildlife hazard managers to clear birds from the runway environment; advance preparation to adjust an aircraft's vertical path to avoid birds; best rate of climb through any altitude band where birds have been anticipated; using extreme caution if accelerating above 250 kt below 10,000 ft; monitoring airport and en route radio frequencies for intelligence about bird activity; using higher rates of descent — without increasing speed — to descend through altitude bands where birds have been anticipated; and considering a go-around if an encounter with birds occurs on approach, subject to other precautions.

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has required only letter reports and updates on progress, he said.

The current situation of inadequate validation of avian radar performance and little peer-reviewed literature on avian radar applications in airport settings will be rectified by studies that both CEAT and the U.S. Department of Defense have under way, Herricks said. Another issue has been inadequate basic engineering research that could lead to new bird-specific radar sensors to supersede today's marine sensors.

Sidelined Strategy

The NABSAS aimed to overcome problems in developing avian radar in 2000–2005. "The purpose of this strategic planning document is to fully integrate all the disparate systems currently under deployment, development or proposal," the plan said. "Many have argued that further and much greater advancement could be made if the current fragmented and competitive efforts could be consolidated in a single cooperative venture."

One phase of the plan would have integrated "small-scale mobile radars … available to monitor local bird movements in real time at select locations," the plan said, building on similar Canadian efforts to upgrade commercial airports. "At the airport or airfield level, dedicated radars must be able to detect birds in the critical airspace, defined as three-dimensional coverage out to 5 nm [9 km] and up to 3,000 feet above ground level," the plan said. "The goal is to provide effective bird strike warnings to pilots flying from one location to another. … Automated warnings [would] be issued when the system has identified potentially hazardous concentrations of birds. One example is heavy migration of large birds in critical airspace."

The decision was made around 2002 by the U.S. Air Force and the FAA to look at commercially available avian radar technologies, Herricks said. "Since these were untried and unproven in civil airport environments, this meant deploying these technologies to airports and conducting performance assessments so that the FAA could obtain technical information that would allow it to identify standards and requirements that could be used in an advisory circular," he said. "The advisory circular will be critical because it basically will define characteristics that technologies must meet to allow reimbursement from the FAA Airport Improvement Program for avian radar funding."

In 2006, the FAA shifted the focus of its airport-related avian radar research, as noted in the FAA 2008 *National Aviation Research Plan*. "The vision of the original [NABSAS] draft focused on providing near-real-time hazard advisory information to a variety of end users such as pilots, air traffic controllers, airport operators and wildlife control personnel. While that long-term objective is still viable, recent lessons learned and advances in technology have shifted the approach toward initially validating current avian radar capabilities, and providing risk assessments for key flight operational zones in the airport environment."[2]

In 2009, avian radar assessments by CEAT support the wildlife hazard manager's work at Seattle-Tacoma. The FAA's schedule calls for additional testing at Chicago O'Hare International Airport, Dallas/Fort Worth International Airport (DFW) and John F. Kennedy International Airport (JFK).

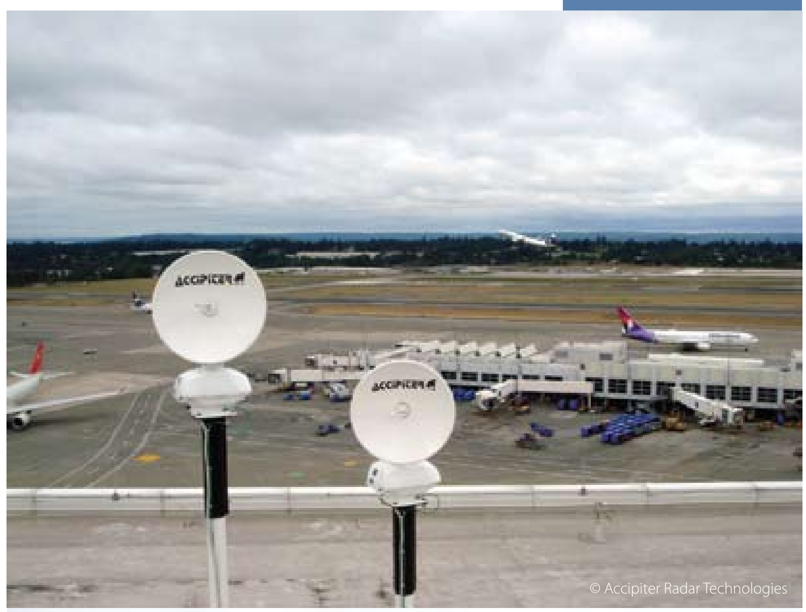
Seattle-Tacoma Experience

Assessment work at Seattle-Tacoma illustrates how details of avian radar can differ from aviation industry assumptions and public expectations. "In cooperation with researchers at [CEAT], we are exploring enhanced wildlife monitoring through the use of an avian radar system that was installed in August of 2007," said Mark Reis, the managing director of Seattle-Tacoma, in testimony at the hearing. "Are we able to accurately track the birds? Absolutely. … The question is, 'What can we do with that data?' At this point, we probably have too much data. The key thing for [future] operations is, 'How do we filter down to the critical data that would be important to air traffic controllers and to pilots?' Or long term, how could airports better understand the dynamics of the bird populations around the airport and what we can do about them?"

The safety factor of providing timely avian radar data to an airport wildlife hazard manager cannot be underestimated. "We are learning about bird population habits beyond what we already knew," Reis said. "We are learning them with greater accuracy, and we can learn 24 hours a day, 365 days a year as opposed to when people are able to observe [bird activity]." FAA and airline flight safety specialists will have to

Top: Performance of roof-mounted avian radar currently is being assessed by CEAT for the FAA at Seattle-Tacoma.

Bottom: Durban International Airport, South Africa, plans to install displays in its air traffic control tower linked to mobile avian radar.



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determine how real-time tactical use of the data by ATC and pilots would occur later, he said.

Herricks remains resolute that avian radar validation at large civilian airports and resultant requirements and standards have to precede any real-time applications. "I don't believe at this point that any avian radar is capable of operating within the complex environment of civil airport operations at even moderately busy commercial airports," he said. "It is not a turnkey situation where we turn these radars on and automatically we prevent bird strikes. I agree with the FAA that these systems are not ready for prime time. … All of the data that we have to date — including lots of experience at Seattle-Tacoma — indicate that we have still got a ways to go. But that doesn't mean that we can't provide quality information to the airport system to make things safer now."

Part of the reasoning behind this policy position is that avian radar is not just a matter of technology issues but concepts of operations, achieving buy-in of stakeholders, developing communications systems and deciding how to safely and reliably communicate alerts to ATC and pilots in time for them to take action, he said.

One example of a recurrent glitch seen in CEAT assessments is occasional disappearance of some bird targets on avian radar. "We see a big bird that shows up very well on the radar," Herricks said. "We see it flying, and then all of a sudden, that track disappears. It may be that we can pick up that track a little later. If the clutter environment is relatively intense, the signal associated with the bird will be lost in that background noise. … We are now mapping the clutter environments at O'Hare, JFK and DFW from multiple locations; we have done 23 sites at O'Hare. We also discovered at Seattle-Tacoma that if we put the radar in a ground depression, this actually improves the performance of the radar by a significant amount."

Outspoken Critic

DeTect, a U.S. manufacturer of avian radar systems, disputes the basis of the policy position at the FAA and CEAT. "Advanced bird radars from several manufacturers are in operational use by the U.S. Air Force, U.S. National Aeronautics and Space Administration (NASA), the U.K. Royal Air Force and several U.S. and foreign airports, airfields and ranges," said Gary Andrews, general manager and CEO. Unlike systems assessed by CEAT at Seattle-Tacoma and elsewhere, "the DeTect Merlin avian radar system has been and is being used tactically by the U.S. Air Force at five U.S. locations since 2003 and by NASA launch controllers at Kennedy Space Center since 2006 with real-time bird radar displays in the control towers/launch control center and data used to make tactical decisions," he said.

Most avian radars used at U.S. sites in this decade have been made by Accipiter Radar Technologies, DeTect and Geo-Marine. "Much of the current level of technology is limited by what users will currently pay for a bird radar system," Andrews said. "In March 2009, DeTect will announce its next-generation bird radar, which will be a solid state, all-weather system that will detect and alert bird strike risk in wet fog and moderate rain." Merlin is not "blinded" by light rain or wet fog, he said. "We are also 'Dopplerizing' [adding Doppler marine radar sensors to] our first system and expect to introduce it in late 2009 or 2010. True three-dimensional systems will likely become available as the technology gains greater acceptance, return on investment is further demonstrated, and the additional cost for the system can be justified."

DeTect's tactical concepts of operation vary by site but generally include a specialized display — called Merlin ATC, designed with input from air traffic controllers and pilots in 2003 and 2004 — that provides "continuous, real-time display and monitoring of bird activity in the runway approach and departure corridors with the current 'bird strike' risk level displayed in color-coded text above each corridor with low risk as green, moderate risk as yellow and severe risk as red," he said. "Merlin ATC is currently used in the control tower only at military installations," Andrews said. "The Durban International Airport in South Africa will be the first use of Merlin ATC in the tower [of a civilian airport]."

The system is fully automated and does not require full-time monitoring because when the bird hazard risk level increases, an audible alert directs the controller's attention to the risk condition, risk location and precise altitude on the display, he said. Risk thresholds are defined and set in the software so that insects do not contaminate the data, and only birds that pose a risk to specific airframes are factored into the ATC displays and alerting. Military wildlife personnel also have real-time radar displays on mobile wireless devices to help them respond more quickly to hazardous bird activity.

CEAT has received funding to lease the DeTect Merlin system for assessment at DFW, Herricks said. The FAA hopes to broaden its knowledge from working with the Merlin system, he added. "We have been working madly for six to nine months to try to get the money out the door to go to DeTect," Herricks said.

CEAT and FAA recognize the need to use all available expertise, he said. "I don't think there is any company that has thought more about how to get information into the ATC-pilot decision-making framework than DeTect," Herricks said. "I also want DeTect in our performance assessment because nobody has the experience that they have with vertically spinning radars. They can provide information about altitude — the missing feature in virtually all our radar work to date. We get some altitude discrimination with dual four-degree radars — parabolic dish types — but it would be nicer to have greater discrimination."

Responding to Andrews' criticisms of assessment time spent by CEAT compared with military and NASA programs, Herricks said that these comparisons are not valid. CEAT's position is that avian radar research for civilian commercial hub airport environments is significantly different in character, scope and complexity from these military and NASA contracts.

Accipiter Perspective

Seattle-Tacoma and the other U.S. civilian airports deploying avian radar through CEAT — except DFW — use systems from Accipiter. Beyond the three mentioned, Accipiter's current military installations include Naval Base Ventura County in California and Elmendorf Air Force Base in Alaska.

"Eventually, bird advisories generated in real time in response to significant and risky bird movements identified by radar will find their way into ATC operations in a manner analogous to weather advisories," says Tim Nohara, president and CEO of Accipiter. "The public and news media may consider this the [ideal application] — which may in fact drive political support for federal funding — but I believe the more important application in improving flight safety is providing airport wildlife control personnel a greatly improved bird situational awareness."

Two of the CEAT research sites — Naval Air Station Whidbey Island, Washington; and Marine Corps Air Station Cherry Point in North Carolina — each have generated a year's worth of avian radar data, enabling for the first time retrospective overlays of bird tracks and aircraft flight paths on the same GIS map. "We are taking one month's data at both sites and refining the process of identifying/extracting near-miss events (NMEs)," Nohara said. "Once we've refined the procedure, we will apply it to the year's data sets. We will analyze NME patterns over time, compare them with reported bird strikes over the same time and confirm correlation," i.e., that they follow the same trend. "We are getting a measure of how tightly the airspace is packed with birds in the vicinity of an aircraft, rather than counting birds alone, or counting bird strikes alone, to provide a more sensitive indicator to a change in safety," he said.

Manufacturers typically enhance performance with their own system design innovations or by adopting newly invented radar sensors, antennas or other components. "We have developed the first dual-beam, height-finding avian radar prototype — with patents pending — and it is ready to undergo three-dimensional tests against remote-controlled aircraft in spring 2009," he said.

Each new generation of marine radar sensor can open possibilities of better avian radar performance at commercial hub airports. "Vendor literature suggests that improvement in bird detection in clutter will be achievable, but at a cost increase of about $100,000 per unit," Nohara said. "Multi-sensor integration in the past year has included integration [of marine radar] with a number of cameras. … Having the radar automatically classify birds into different species or groups is still in the research and development domain."

Staying The Course

Misunderstandings of what avian radar can do have the potential to set back CEAT's process of moving avian radar toward acceptance and utilization, Herricks fears. "We can't afford to have a tool that provides so much potential fall prey to that, so we have to have expectations that are realistic," he said. Realism about avian radar also means understanding policies and procedures required for safe insertion of this technology into the ATC decision-making framework, he added.

The Flight 1549 accident report and the forthcoming reports by CEAT on its avian radar assessments may quell the current controversy about avian radar by clarifying logical next steps. Better information about detectable bird hazards — possibly including real-time alerts to ATC and pilots — will require better collaboration among all stakeholders willing to take time to understand the complexity of avian radar systems, the civil airport environment and the ATC implications while assessing risk under safety management systems.

To read an enhanced version of this story, go to the FSF Web site <www.flightsafety.org/asw/mar09/avianradar.html>.

Notes

1. FAA; Transport Canada; U.S. Air Force. *North American Bird Strike Advisory System: Strategic Plan*. April 2005.

2. FAA. *2008 National Aviation Research Plan*. Feb. 4, 2008.