BIRD DETECTION RADAR

DeTect's MERLIN bird detection radar systems, which have been operational at USAF and NASA installations for several years, are now integrated into a commercial airport's operations

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Bird detection using marine radar systems has been a fairly common practice in academic studies and for various applied uses for decades. Over the past 10 years improvements in hardware and computing power have dramatically transformed the use of these systems from simple user observations to more sophisticated tracking and automated data processing and archiving features. The US Air Force first began using marine radar in 1994 to study bird movements at the Dare County Bombing Range in North Carolina. Several field studies followed through the late 1990s, and a full-time radar system was deployed in 2006 at Dover AFB, DE. This radar system was deployed to not only provide historical movement patterns of birds but also to provide a real-time advisory capability to assist the wing with determining bird watch condition codes. These codes are specified in the unit Bird Aircraft Strike Hazard (BASH) Plan and each category has specific flight restrictions associated with it. Bird detection radars are now in use at other Air Force installations as well as at several Navy airfields.

The integration of bird detection radar output into military operations can be accomplished through a variety of methods that are not typically available at commercial airport operations. For US Air Force applications the unit BASH plan provides specific guidance for integrating the radar risk output, which generally involves the supervisor of flying (SOF). Although conventional thinking is that the flexibility in military operations lends itself to bird avoidance technology, the urgent pace of operations at many commercial airports may not be conducive to interruptions of traffic flow due to increased bird strike risk. However, the urgency of military combat operations and the extreme costs associated with delaying flight of the space shuttle have been shown to be balanced against the risk of severe damage or loss due to a serious bird strike. MERLIN bird detection radar systems have been mission essential on all space shuttle launches since July 2006. In May 2010 the first bird detection radar for use in a combat environment was installed at Bagram Airfield, Afghanistan.

Bird radar goes commercial

In preparation for the 2010 FIFA World Cup, South Africa began a series of infrastructure improvements. One of the most aggressive projects was the construction of a new international airport north of the city of Durban. The relocation of this airport had been planned since the 1970s, and land had been acquired and cleared for this purpose. However, other priorities resulted in this construction being delayed. In 2006 Airport Company South Africa (ACSA) began the environmental assessment process to build the new airport near the town of La Mercy. As the assessment progressed it became apparent that a nearby swallow roost was going to require a detailed analysis to determine if the birds would pose a risk to aircraft operations and what impact, if any, would be suffered by the birds in the roost.

In 2007 a bird detection radar system was deployed to study the bird activity at the reed bed that is located approximately 2.3km from the runway threshold. The three-month study indicated that the roost contained a substantial number of birds (1.3-2.5 million), which would periodically pass in moderate numbers through the aircraft flight paths. These birds are only in the region during the summer months (October-April), and have fairly predictable morning departure behaviour. Afternoon activity was more variable and occasionally the birds would soar into the approach path above the reed bed. After careful consideration ACSA decided that monitoring the bird activity during these periods would be warranted, and the implementation of the radar was directed in the record of decision.

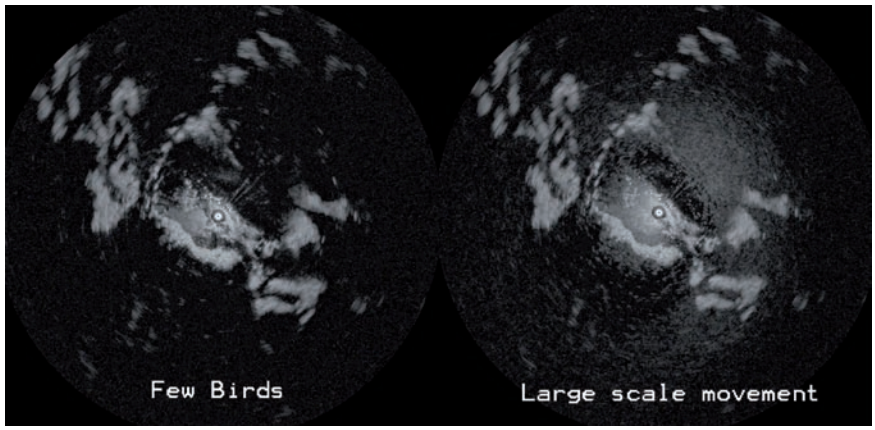
Installation and calibration

In 2009 a bird detection radar system was installed at the new airport site. During the next 12 months radar data and high-definition video data were recorded to assist in calibrating the system and to aid in development of special detection algorithms to deal with the flocks of swallows when they left the roost in the morning and returned later in the day. The swallow detection algorithm was designed to integrate vertical and horizontal radar data in the approach and departure zones, with special consideration to the swarming nature of these small birds (less than 19g), which present a target similar to weather.

Stakeholders' input

In addition to developing site-specific processing for the radar system, it was apparent that integrating the radar output for real-time use would require a great deal of coordination and input from the various stakeholders. Meetings were conducted in Johannesburg in early 2009 with representatives from the Air Transportation and Navigation Service (ATNS), air carrier flight safety representatives (South African Airlines, Kalula, Mango, One Time, etc.) and airside operations personnel from ACSA. The purpose of the meeting was to determine what kind of advisory would be practical for use at the new airport. While all parties agreed that some kind of advisory would be useful, there

Main image: vertical view of swallow swarm. Bottom row, left to right: Bagram Airfield, vertical radar with approaching 737, control tower at tower King Shaka International Airport



Radar display of movements

was some disagreement as to what levels of information should be available, and how that information should be displayed. The record of decision, however, was a guiding hand in laying the foundation. According to the final document, there would be a radar-based advisory system and flight restrictions would be an option.

Integrating a radar-based advisory

Initial discussions involved two areas of concern. The first was the development of a safety case analysis to ensure that the radar system would: a) do no harm; and b) provide an improvement in the current system of advisories. The second concern was determining the procedures that would be followed when a radar-based advisory was presented. The safety case study used the previous NASA test and evaluation utilised for the MERLIN bird detection radar system currently implemented at the Kennedy Space Center in support of space shuttle launch requirements. This analysis was focused on detection of large birds in a high-clutter environment, but was sufficient to provide assurance that marine radar can safely detect large-scale bird activity.

Additionally, data and field observations from the initial radar evaluation of the bird roost in 2007 as part of the environmental assessment clearly indicated that the radar system would detect both departure and arrival activity. Further, it was determined that air traffic control staff spend very little (if any) time each day actively searching for birds around the airport. With radar updating every 2.2 seconds, the number of observations of the atmosphere was dramatically improved. A remote sensing technology, regardless of its level of proficiency in detecting potentially hazardous targets, would not only do no harm, but would improve the current condition.

Operational procedures

It was clear from the beginning that there would not be an additional radar display placed in the tower cab. Air traffic control facilities are not staffed with full-time bird radar observers; nor are current staffing levels sufficient to allow staff to watch another screen. While the movement in military bird watch conditions codes appear to be evolving from a simple Low, Moderate, Severe advisory to a more sophisticated or finer definition of risk, the opposite direction evolved from the workshops held in South Africa.

The initial proposal to provide a similar hierarchy of advisories was soon distilled into a simple green light/red light configuration. ATNS officials were not interested in trending. If conditions were getting worse they would know it when the light turned red. A yellow light, they contended, could go back to green as easily as up to red, and they did not want to be concerned with changing conditions until they were ready to implement some operational procedures. The wildlife control staff, however, were interested in the trend and wanted to preserve the intermediate risk calculation. The decision was to provide the ATNS staff (tower) with a simple 'light' indicator on their existing integrated information display system (IIDS) that would indicate green when conditions were low, and red when special operations were warranted. A grey light box indicated when the radar or network were down.

A green light box only indicates that the radar is not detecting a hazardous level of bird activity. It does not replace the existing visual methods of bird and wildlife activity reporting that the airport has been using at the previous location – it supplements those methods. When the radar system detects a hazardous level of activity, the light box turns red and the following procedures were agreed on by the ATNS representatives, the Civil Aviation Authority, ACSA and the air carriers present at the safety meetings:

- Tower will contact the Wildlife Control Officer to verify/identify activity. The wildlife control team is located at the fire/rescue facility and has immediate access to the airfield. Additionally, the wildlife control team has radar displays that indicate where the severe risk level has been detected on the airport
- During swallow season (September through April) aircraft departing towards the Mt. Moreland reed bed will be held until the red light has gone back to green
- Aircraft approaching King Shaka International Airport will be provided with an advisory indicating that radar has detected a severe level of bird activity on the approach (if the approach is over the reed bed)
- Approaches and departures will be directed towards headings that do not over-fly the reed bed (if winds allow)
- If the red light box is illuminated during periods of time when the wildlife control team is not on the airport (sunset to sunrise), aircraft will be held for departure until the light returns to green and approaching aircraft have been given a general advisory

Resistance to change

It has been stated for many years and by a wide variety of sources that it is unlikely that air traffic control would delay take-off or landing operations at a commercial airport even if radar (or any other source of detection such as remote camera systems, pilot reports or reports from operations staff) indicated an elevated level of bird activity on or near the movement areas. Further, it is often stated by air carriers that they are unlikely to take any operational actions when provided with a general advisory of bird activity. While no one in the advisory chain of command suggests that aircraft are clear to depart or land when a truck (or an elephant) is on the runway, there is great

ambiguity about what to do if there are 25 gulls on the runway, or 15 geese. The case at King Shaka International Airport, however, was set in action by the record of decision from the environmental impact study. All parties involved in the assessment agreed that the site-specific conditions at the airport, the swallow roost at the reed bed in particular, required extraordinary monitoring and operational consideration.

King Shaka International Airport began commercial operations on 1 May 2010. The MERLIN bird detection radar system had been on-site for over a year prior to the airport opening, and is currently providing real-time updates for operations. The swallow roosting season had just ended when the airport opened. Over the next six months the wildlife control team and the ATNS staff have the opportunity to record how well the radar improves understanding of bird activity at this new facility and to prepare for the arrival of over two million swallows in the spring.

Summary

The integration of any remote sensing technology into a bird hazard advisory system inherits all of the long-standing issues that have surrounded this topic for decades. Every airport has unique environmental conditions which establish a background level of risk. This risk changes daily as well as seasonally, and is difficult to quantify because different aircraft have different vulnerabilities to bird strike damage. Additionally, each airport has a wide range of operational factors, such as the tempo of aircraft movements, seasonal weather conditions and construction activities that press the aircrew and air traffic controllers to keep pace. It is against this very complex background that a bird/wildlife hazard advisory must be determined and communicated to all stakeholders. The current situation at most airports is that few (if any) routine observations are made of the atmosphere around the airport to determine levels of bird activity and subsequent risk. The integration of remote sensing tools such as radar will dramatically improve our understanding of the level of hazardous activity on and around the airport, and provide the basis for continuing to evolve risk thresholds and operational responses. ❖

Dual screens