CURRENT WORK ON BIRD HAZARDS TO AIRCRAFT

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ABSTRACT: Collisions between birds and aircraft have caused loss of human life and millions of dollars worth of property damage. The advent of even larger planes may reduce airframe damage, but it seems doubtful that engine damage will be significantly reduced.

Dealing with the problem biologically, involves combating the hazards caused both by birds on or near the ground at airfields, and by birds on mass migrations at altitudes up to several thousand feet above ground.

Airports can be designed or altered to minimize their attraction to birds. The chance arrival of a flock of birds must be treated as an emergency with all available equipment and personnel used to ensure quick dispersal.

The hazards caused by birds aloft must be dealt with by making it possible for aircraft to avoid the main bird flocks. Warnings of the immediate presence of birds can be given by air traffic control operators, trained to recognize birds on their radar. The ability to forecast the probable presence of flocks of birds on migration is now being developed.

The first fatal aircraft accident caused by birds killed one person at San Diego, California, in 1910. Fifty years later, an Electra aircraft hit a flock of birds near Boston Airport and crashed - more than 60 people were killed. In 1962, a Viscount aircraft collided with two whistling swans and crashed near Baltimore - killing 17 people. Since then, a number of smaller accidents have taken place in the United States. In the last 10 years, aircraft-bird collisions in the United States have caused about 100 deaths. We are fortunate that the number of deaths has not been greater.

In many cases bird strikes have damaged aircraft. Replacing aircraft parts damaged by birds cost the United States Air Force between 10 and 20 million dollars in 1968. I do not have figures from the major commercial air carriers in the United States, or from the Federal Aviation Agency, but they are probably of the same order. Several years ago, British Overseas Airways Corporation published replacement costs of more than a million pounds sterling a year. In the early 196O's, Canada's largest airline, Air Canada, estimated five-year costs for the period ending 1963 at about 1.2 million dollars.

Here are some details from recent incidents. On May 12, 1969, a 737 Boeing aircraft approaching the airport at Winnipeg, Manitoba, struck a group of eight (we think) snow geese. Blue and lesser snow geese were migrating at the time and about a quarter of a million were moving northward. The aircraft skin over the co-pilot's position was ruptured, the lower surface of the fuselage, the wing leading edge and both engine cowlings were damaged. If the impact on the engine cowlings had been a few inches closer to the centre line of the engines, ingestion of parts of the birds would have caused serious loss of power or complete engine failure. Power loss on both engines of the twin-engine jet would have meant a very dangerous landing and probable disaster for the aircraft's 80 passengers. As it was, the only result was an aircraft crippled for three weeks. The impact of the multiple-goose strike was so severe that collision with another aircraft was the crew's first thought.

In November 1967, a similar bird strike by a DC-8 out of Cleveland, Ohio, injured the co-pilot, destroyed a windshield panel, and damaged parts of the air frame. In spite of loss of cabin pressure and other difficulties, the aircraft was able to make a safe return to base.

In July 1968, a Falcon Executive aircraft, also out of Cleveland, encountered a large number of gulls immediately after take off. Damage to the aircraft was severe - both engines lost power, the aircraft plunged into Lake Erie and sank. Fortunately, only the flight crew was aboard. None of the crew was seriously injured, and all managed to swim to shore.

As we move into an era of larger aircraft carrying more and more passengers on a single flight, we expect the chance of an incident involving a large loss of human life becomes greater. In modern jet aircraft the engines and the tail surfaces are most vulnerable to damage by bird strikes. As aircraft get larger, airframe components become larger and stronger. In the jumbo jets, damage to stabilizers is less likely than was the case with the Viscount aircraft which crashed after one or more whistling swans struck its port horizontal stabilizer. As engines become larger, their frontal area will make up an increasing proportion of the frontal area of the aircraft. The chance of engine strikes will be greater on jumbo jets than on jets now commonly used, including the DC-8, 707, and VC-10.

Engine manufacturers say that the large components decrease the likelihood of engine damage. I hope that is true, but experience makes me skeptical. Look at this fan blade from a DC-9 engine. It is made of titanium which is rather hard material. Nevertheless, damage to that blade and the write-off of the rest of the engine, was caused by ingestion of one ring-billed gull at Montreal Airport a couple of years ago. I could have brought along bits of scrap metal from other turbine powered aircraft engines which were demolished by impact with not very large birds.

There is safety in engine numbers. The chances of destroying, at the same time, two engines on a four-engine aircraft are not great. On four-engine aircraft, we have records of twin-engine strikes on take off and two- and three-engine strikes on approach for landing. Damage on take off may be limited to the affected engines, or if the aircraft cannot be stopped before reaching the end of the runway, may include the airframe. As for landing, the airlines have shown that a four-engine aircraft can land with two, or even one, normally functioning engines. I leave it to you to figure out the effect of twin-engine strikes on two- and three-engine aircraft.

In reducing bird hazards to aircraft, we must reduce the numbers of birds on airfields, which used to be the most important part of the problem in civil aviation in Canada; and we must arrange for aircraft to avoid mass migrations of large birds aloft.

Making airfields less attractive to birds has been discussed in a number of earlier papers (Munro and Harris, 1963; Solman, 1966, 1968, 1969, and 1970). An airport is a large area relatively free from disturbance by man and domestic animals. Although it may not provide food, shelter or water, it may still attract a number of birds.

An airport should be designed and built to minimize bird attractions. It is more effective and cheaper to build the airport correctly in the first place than to modify it later. If the airport already exists, expensive modification may be needed. Sources of food, shelter and water, which may include foundation plantings and ornamental architecture, must be eliminated or modified.

Once the airport environment has been made as unattractive as possible, the unexpected arrival of numbers of birds - an emergency comparable to a sudden snowfall - must still be dealt with. At Canadian airports, a sudden snowfall alerts the snow removal forces. If necessary, snow clearing begins immediately and continues until the emergency ends and runways and other facilities can be used normally. Arrival of birds must be treated with the same urgency. Staff and equipment must be used to drive the birds away repeatedly until they leave the area and the emergency has passed.

The main problem is really one of human motivation. At airports where the manager and staff are aware of the dangers posed by birds and are willing to work hard to deal with them, bird hazards to aircraft are kept to a minimum. Where the management is insufficiently concerned, birds continue to cause damage to aircraft and hazard to human life.

The result of airport environmental change to reduce bird hazards is well shown by the hardware replacement costs of a Canadian airline. The annual average hardware replacement cost for a five-year period ending in 1963 was $238,000. In the next five-year period ending in 1968, the annual cost dropped to about $125,000. For the calendar year 1969, the cost was less than $50,000.

Though not as easily dealt with, the problem caused by birds on the airways can be overcome by using available devices. We have had general information on bird migration for a long time and can obtain additional details by means of radar or by radio-tracking of birds equipped with transmitters. We have used both methods. Bird movement shows up well on plan position indicator radar used for air traffic control throughout North America and in many parts of the world. Many defense radars, and some weather radars, are also useful for bird observation.

Many radar operators believed they could not see birds on their radar equipment or, for that matter, on any radar. Radar operators to whom we show time-lapse movies of radar presentations of birds agree that, without realizing it, they must have been looking at birds ever since they began observing radar scopes. The techniques for taking those movies were described by Gunn and Solman in 1967, and Solman in 1969.

Seeing bird echoes on a radar screen is one thing; interpreting the meaning of the echoes, and assessing potential hazards to aircraft, is quite another. Training operators to recognize and respond to bird echoes on radar is straight forward and necessary; and is now being done in southern France using filming techniques and interpretation ideas developed in Canada.

Some air traffic controllers are reluctant to take on the responsibility of watching for and dealing with bird hazards aloft. They feel that keeping aircraft apart and steering them away from unfavourable weather and turbulence are sufficiently difficult problems. Because of the emphasis on the dangers of thunderstorms and associated turbulence, the Department of National Defense of Canada has not lost any Starfighter aircraft from those causes in the last five years. It has lost 10 of those aircraft through bird strikes in the same period.

We can now make forecasts of major migrations of large birds and are working hard to improve their accuracy. But migration forecasts are not enough. They must be supplemented by current radar observations of bird groups, and the information passed on to pilots. We believe the additional cost of providing bird information is a small price to pay for a substantial reduction in hazard to human life and a reduced cost of airline operation.

Pilots from different countries and their national and international associations, are now conscious of the hazard posed by birds. Five years ago, few pilots were aware of or interested in the problem. Now, all are eager to talk about it, relate their personal experiences and those of their colleagues, and offer constructive suggestions for reducing it. Suggestions range from greater structural strength in certain aircraft components, to better warnings to pilots so that they can avoid dangerous areas and periods of mass migrations of large birds.

In northern Europe, where work like ours is going on, the populations of large birds are smaller than in North America. Germany, France and neighbouring countries have migrations of 25,000 cranes across many of the airways. In North America, about 350,000 Sandhill cranes, 5,000,000 geese of several species, 100,000 whistling swans, and 60 to 100 million ducks cross the airways. The number of aircraft using the airways in North America is higher than in any part of the world.

To make aviation as safe as possible we must move rapidly from experimental forecasting of major bird migrations - now provided to the Department of National Defense in Canada - to airline use of migration forecasts supplemented by radar confirmation.

Forecasting the intensity of migrations is not yet an exact science, although in some experiments an accuracy of 70 per cent has been reached. Migration forecasts are based on weather forecasts, because weather is the most important factor in long-range migration of large birds. We have not yet pinned down the exact mechanism that initiates bird migration, but we are trying to do so by using regressions between masses of migration data from nearly two hundred miles of time-lapse movies of radar presentations and weather data provided by stations where the radar observations were made and stations up stream in the bird flow.

We believe that birds begin exploratory flights after integrating observations of the passage of weather phenomena. As far as we know, with blue and lesser snow geese at least, after a large group of birds go into the air, they fly along a migration track for about an hour and reach altitudes used in migration before deciding whether it is a good time to migrate. If they decide against migration, the whole group returns to its starting point which may be 50 miles away. They continue feeding and resting until another triggering action sends them into the air for another weather check. When they decide to continue migration, they are already part way on their migration route and need merely fly on in the same direction, climbing to a higher altitude more suitable for long-range flight. The geese appear to base their decision to continue migration on wind speed aloft and their resultant ground speed. We do not know how geese or other birds decide to continue a long migratory flight. We may not be able to duplicate the process by computer. As we learn more about the weather-migration relationship, we can get closer to the same answer as the birds although we may reach it in a different way. What we must have is the ability to forecast the time, location and duration of maximum bird hazard so as to divert aircraft from them. Flying in Canada and some other countries is now safer than it used to be, not only because we have improved general flight safety, but also because we are now keeping birds away from airfields and have made a start on keeping aircraft away from concentrations of birds.

I believe that we will reach a point where aircraft are refused flight clearance because of the hazard caused by short-duration high-density bird migration. We believe it makes no more sense to descend or ascend through a very dense curtain of migrating geese than it does to fly through the most severe turbulence in a thunderstorm. Some airline officials, and many pilots, are coming to share our opinion.

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