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V. E. F. Solman
Canadian Wildlife Service, Department of Northern Affairs and National Resources, Ottawa, Ontario, Canada

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Gentlemen, I have an apology to make, first, two apologies. One from the Associate Committee on Bird Hazards to Aircraft of Canada, that more members of that committee could not be here to take part in this session. We're very much interested in the deliberations. The second apology because our new film, which is a training film for airport operators to show some of the things we've been able to do and why we've done them and how we've done them, was scheduled to be ready for me to bring to this meeting. At the last minute, the processing machinery of the contractor who was producing the film broke down and the film will not be ready until later this week. So, I am going to have to substitute slides for a film, but I want you to know that the film is available and I think it will be useful to people who are dealing with these problems. It can be made available to anyone who wants to look at it. So, with that pair of apologies, I'll go ahead.

The Canadian Wildlife Service has had twenty-five years experience with the problem caused by bird contacts with aircraft. I experienced my first bird strike, while flying as an observer on a waterfowl survey in August, 1940. Officers of the Service investigated bird problems at airports at Yarmouth, Nova Scotia, and Cartierville, Quebec, in the late 1940's. Those incidents involving gulls and low speed piston-engined aircraft caused minor damage to the aircraft but considerable disturbance to the operators.

As aircraft speeds increased and airports became more numerous and busier the problem increased in extent and complexity. By 1960 it was apparent that the problem would grow worse and that work should be directed toward reducing the number of incidents. In 1960 an electra aircraft crashed at Boston, Massachusetts, killing 61 passengers. Starlings were involved in the engine malfunction which preceded the crash. In November, 1962 a viscount aircraft was damaged by collision with two swans between Baltimore and Washington and crashed with a loss of 17 lives. Those incidents focused attention on the bird hazard problem in the United States (Plate 1).

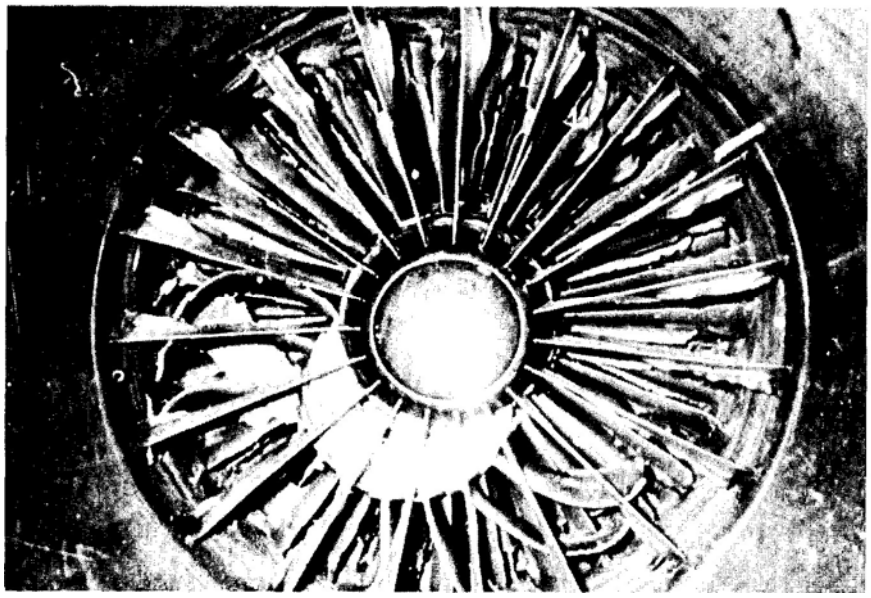
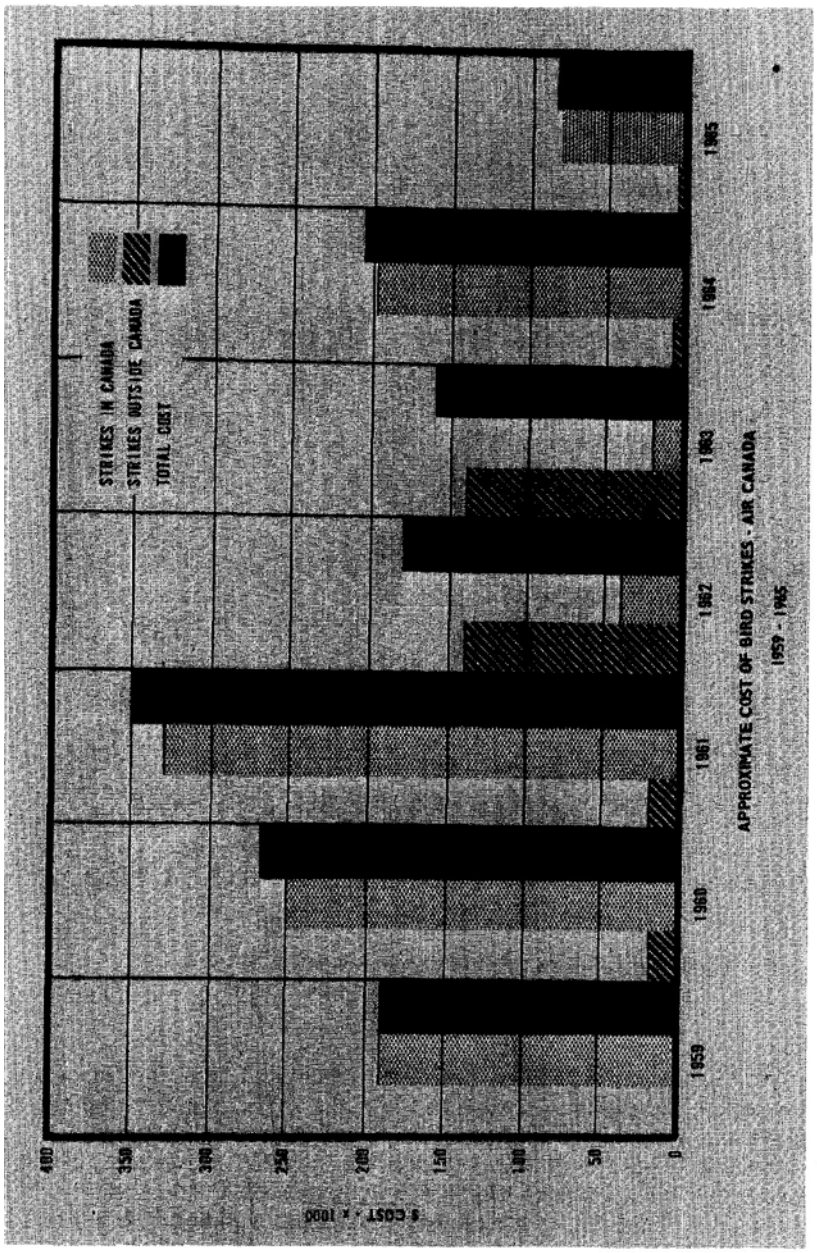


Plate 1. Fractured turbine blades of a jet engine due to bird ingestion.

Prior to the United States crashes in 1960 and 1962 the Canadian Wildlife Service had been working with the R.C.A.F., the Department of Transport and Air Canada gathering data on bird strike occurrences and the magnitude of the problem (Graph 1). In 1963, at the request of the Department of Transport, the National Research Council set up the Associate Committee on Bird Hazards to Aircraft to study the problem and recommend solutions.


APPROXIMATE COST OF BIRD STRIKES - AIR CANADA
1959 - 1965
STRIKES IN CANADA
STRIKES OUTSIDE CANADA
TOTAL COST
$ COST - x 1000
400
350
300
250
200
150
100
50
0
1959
1960
1961
1962
1963
1964
1965

Graph 1.

The Associate Committee, with representation from the Department of Transport, the National Research Council, the Royal Canadian Air Force, the major commercial airlines, the Canadian Aeronautics and Space Institute, Canadian Rolls Royce Limited and the Canadian Wildlife Service, has met repeatedly. Initially, the problem was considered to be partly of an engineering nature and studies were begun to determine the necessary strength of aircraft components to resist bird impact without serious damage. It soon became apparent that because of the weights of birds involved and the speeds of aircraft, not much engineering improvement would be done until international standards were agreed to. There is no agreement yet on international standards for bird weights which aircraft structures must resist. Proper engineering applications have not been made by any manufacturer because to do so would put the aircraft or engine manufacturer at a disadvantage in competition with other manufacturers who did not accept the same standard. Ultimately, international standards may be agreed to and from that time on progress may be made toward reducing bird damage by engineering methods. It is unlikely to be possible to protect aircraft components fully against high speed bird impact because of the very large stresses involved. To make a completely bird-proof aircraft would involve creation of a structure of such weight that flight would not be economically feasible.

When the difficulties of dealing with the problem of engineering methods were realized the Associate Committee directed its major effort toward biological solutions. Biological studies were conducted at a number of airports to learn about the bird species involved, the reasons why they were present on airports, and what could be done to disperse them. In addition, studies were made to determine ways of making airports unattractive to the birds concerned. More than 50 airports have now been studied in detail by officers of the Canadian Wildlife Service or by contractors working under direction of the Canadian Wildlife Service, using funds provided by the Department of Transport, the Canadian Wildlife Service and the National Research Council.

While it was known initially that gulls and starlings were often involved in bird strikes on aircraft we soon learned that many other bird species were involved. The following birds have been identified as having struck aircraft:

Common loon
Great blue heron
Mallard
Pintail
Green-winged teal
Red-shouldered hawk
Hungarian partridge
Ring-necked pheasant
Kildeer
Golden plover
Black-bellied plover
Upland plover
Baird's sandpiper
Dunlin
Great black-backed gull
Glaucous-winged gull
Herring gull
Ring-billed gull
Rock dove
Great-horned owl
Snowy owl
Short-eared owl
Nighthawk
Black swift
Barn swallow
Cowbird
Lapland longspur
Snow bunting
Swamp sparrow

The main problem is to determine the cause of bird presence at airports and, as far as possible, to eliminate the cause. Such simple matters as relocation of garbage dumps away from airports or removal of other attractions seem obvious now but were not obvious to the airport operators initially. In some cases, complex negotiations with neighbouring municipalities were required to remove the source of attraction. Some negotiations for removal to a safe distance of garbage dumps and other disposal areas are still going on.

On some airports where there were large acreages of land not being used for airport purposes, crops were grown under lease. Certain crops are particularly attractive to certain groups of birds; for example, corn is very attractive to red-winged blackbirds. Changes in the leasing arrangements for agricultural land use have been made at several large airports to ensure that crops now grown are as unattractive to birds as possible. In some cases the production of commercial crops has been discontinued and the whole airport area is maintained by the operating agency, usually the Department of Transport.

In some cases the replacement of crops by a grass turf has helped to reduce bird attraction. Grass creates some problems, however, because some species of ducks visit one airport to feed on the grass and have damaged several aircraft. Studies are in progress at one airport and will soon be started at another to learn if other cover plants can be used as a substitute for grass.

Ideally, vegetative cover on an airport should meet certain requirements. In addition to covering the ground and preventing soil erosion, airport ground cover should not attract birds or insects which can be a source of food to birds. It should be relatively flame-resistant in order not to be ignited by jet aircraft exhausts, should be capable of standing a fair amount of wheel traffic and should not require heavy maintenance. We are searching for plant species which will meet those requirements better than grass.

Grass meets many of those requirements but attracts certain birds. It requires constant attention by mowing to maintain it as unattractive as possible to birds. If grass grows too long it provides cover for small mammals which attract predatory birds. If it is cut too short it permits small birds to forage for insects and other soil-inhabiting animals. Neither condition is desirable on an airport. The length at which grass must be maintained to reduce bird attraction falls within narrow limits. At Montreal Airport grass is held between 5 and 7 inches in length while at Toronto Airport it is being held between 4 and 6 inches. Those lengths have proved to be most effective at those two airports.

The Department of Transport has spent several hundred thousand dollars at a number of major airports carrying out biological recommendations of the Committee. The recommendations included such things as removal of surface water by improved drainage, pumping or

filling of low areas, removal of hedges and other nesting cover, removal of roosting trees, removal of unused buildings and other potential nesting sites. All of those actions are important in rendering some airports unattractive to birds.

In addition to modification of habitat to remove the problem, the Associate Committee has tested many means of dealing with emergent bird problems. Those have included pyrotechnics, trained falcons, recorded distress and alarm cries, and various scaring devices. The most useful device is a reliable exploding shotgun shell used by a trained operator.

In addition to the problem birds cause near airports for aircraft taxiing, landing and departing, there is a problem caused by birds encountered in flight away from airports. Known bird contacts with aircraft have occurred up to altitudes of 21,000 feet. In studies conducted for the Committee by the Division of Applied Biology, National Research Council, birds have proved capable of remaining conscious and performing useful work at simulated altitudes as high as 30,000 feet. The bulk of bird movement on migration takes place below 10,000 feet.

Beginning in the autumn of 1963 we have used radar to study bird migration. Plan position radar as used for airways traffic control and for National Defence purposes provides clear images of birds. Through the cooperation of nine Department of Transport radar stations and nine stations operated by the Department of National Defence it was possible to achieve continent-wide coverage of the spring and fall migrations of birds during 1965 as well as less complete coverage in the fall of 1964 and experimental work at Toronto in the fall of 1963. We photograph the radar scope image with a motion picture camera on a time-lapse basis. One exposure is made for each 10-second sweep of the radar. The resulting films, projected at normal speeds, provide a speed-up of 240 times which permits a 24 hour radar watch to be reviewed in a few minutes. A study of the radar films has revealed much about speed, direction, duration, timing and intensity of bird migration at the locations under radar view in the form of 150-mile circles. It has been possible to correlate bird movement with weather patterns and to confirm much of what was believed from less-sophisticated past studies.

The Canadian Wildlife Service is devoting much intensive study to the major migratory movements of large birds capable of causing serious damage to aircraft in flight. Those movements involve something like 30,000,000 ducks, 5,000,000 geese, 350,000 sandhill cranes, 150,000 swans and several thousand pelicans moving south in the autumn and somewhat smaller numbers moving north in the spring across the major east-west airline routes of both Canada and the United States. The potential for serious accident exists. Not enough height-finding radar equipment is available to provide as much height information as we would like to have. Information from pilot reports and from the limited height-finding radar gives us a rather clear picture of the

sort of hazard that exists for limited times at specific points during migration.

The Department of National Defence is particularly interested in the bird problem because it has lost a number of aircraft due to bird strikes in recent years. Military aircraft are quite expensive. There is also a hazard to the air crew involved. On May 1, 1966, an operational forecast system to provide warnings of high bird hazard during migration went into effect at the R.C.A.F. CF104 training station at Cold Lake, Alberta. It is too soon to assess the value of this system, but the commanding officer of the Station has expressed satisfaction with the experimental study that led to the forecasts.

In addition to the work done at airports and with radar for the Department of National Defence in Canada parallel work has been done in Northern Europe at N.A.T.O. airdromes and using radar facilities of a number of countries.

The complete analysis of about 700,000 feet (125 miles) of 16mm film that resulted from the photographic radar surveillance program is well under way. When it is complete it should be possible to develop an even-better forecast technique to provide high hazard bird migration forecasts for National Defence and airline operators with accuracy similar to that of weather forecasts. With such forecasts it should be possible to reduce the number of bird contacts in flight in a manner parallel to the reduction at and near airports.

Air Canada has experienced a 25 per cent reduction in bird strikes from 1964 to 1965 with comparable flight operations from the same terminals. The first few months of 1966 have shown a continuation of that trend. We believe the hazard to aircraft landing at and taking off from Canadian airports has been substantially reduced through the habitat modification and bird dispersal activities recommended by the Committee.

The Committee has produced about 30 notes on techniques used at various points as well as a number of other types of published material for use by persons facing similar problems. The Committee regularly corresponds with interested workers in more than 30 other countries.

The United States Air Force losses due to bird strikes have increased very much in the last two years. One of the United States astronauts was killed in an aircraft accident involving a snow goose. The United States Air Force and other United States agencies are sufficiently interested in the Canadian program that representatives of the Committee have met with United States officials to begin developing a suitable program for the United States Air Force. The Committee members believe that Canada is probably the leading nation in dealing with the problem of bird hazards to aircraft.

Committee studies have resulted in recommendations for habitat modification at most Canadian airports. Much future Committee

activity will be directed to encourage the rapid accomplishment of the necessary modifications to the airport habitat, to test and refine the radar bird-hazard forecast program and to continue working toward a continental radar bird-hazard forecast network. Only a continental system can provide really effective warning for east-west airline routes in Canada and the United States.

The Associate Committee has prepared a color motion picture film on the habitat modification work carried out so far. It is intended as an aid in training airport personnel in recognizing bird attractions and eliminating them.

Now, as I said, I had a movie which I would like to have shown you and which I hope you will all see at some future time. I have a few slides here and you might see. Bodies of water near airports are a problem and you can place exploders or assign patrols with shell crackers or anything you like to boost the ducks out of there. But the real answer, if it can be done at all, is to either drain the area or fill it. We had one airport, an international airport, opened up about eight years ago, where the major fill material for the main runway was excavated from borrow pits right on the airport property. Needless to say, these borrow pits filled up with water and they now have a bird problem associated with them. These borrow pits involved something like one million three hundred thousand cubic yards of material, so it's going to be a long time getting those damned things filled. Had the designer taken water-filled holes into account at the time of planning, those borrow pits needn't have been on the airport at all. Another airport, built as we now know things, wouldn't have been built that way. However, we have a lot of these problems and we're dealing with them by drainage and filling.

Next. Well, this shows gulls coming in to look at an attraction, and I think on the next slide maybe we'll see; yes, worms on the runway. So these have been mentioned by Ki; and we have them too. Here are worms that wiggled out onto the pavement on a 200-foot runway. They start out from both sides and meet at the middle. And you have two kinds of problems here. You have a problem of attracting gulls, which brings enormous numbers of gulls to some airports at certain times. And, you have the problem that worms are slippery when you run over them. Aircraft may skid on them and you have to go out and sweep the confounded worms off the runways, and on a big runway this costs a lot of money. During the time you're trying to get rid of the worms, the gulls are there trying to help you and contributing to the aircraft hazard. So we're looking for a method of eliminating worms that we can live with.

It's all very well to talk about killing worms by using large quantities of endrin or lead arsenate or any other poison that you may want to talk about. But, in most areas where we have this problem, if you start talking about tonnage lots of materials that would be required to

do this job, you immediately get into trouble with the water resource people who worry about the drainage area downstream, in addition to a whole lot of other people who just don't like to see that much material used. So, at the moment, we're playing around with this. We really don't have an answer. We can tell you this, though: at our airports where we don't have worms, we don't have nearly as many gull troubles. There are a number of airports in northeast Canada which are beyond the range of distribution of earthworms. And at those places we have literally no gull trouble, because the worm attraction is not there.

So, next one please. Oh, that's just a close-up of the concentrations of worms you get along the sides of runways with the cigarette pack in the picture for size comparison. There are all kinds of things around airports. In a coastal airport you can have old wrecked bases for buildings and pilings of all kinds sticking up. We had some hundreds of pilings alongside of a runway at a coastal airport and every one of these had a bird sitting on top of it, of course. In some cases, birds nesting on them. The obvious thing here is to get rid of them, so a crew went out and worked many days at low tide under rather awkward conditions on a floating platform and just cut all of these pilings off below water level so that they couldn't be used for roosting. That cleared up the problem that we had there.

Next one. Drainage ditches. O.K., you can see the runway right behind there. Here's open water. Now this is an airport which is practically at sea level where most of the drainage is carried on by pumping and we have to pump the water up to get it off the field. When the pumps become overloaded, there are times when you just can't get rid of that water so what do you do? Well, the next slide is one possibility. You string wires over it. This is a different ditch in the same field, but with wire strung across to prevent birds from alighting. That certainly kept the ducks out of there. It's not a pretty thing to look at, but it solved that problem until we could revise the drainage program on that field.

The next one. Oh, well, this was our classic. Can you envisage a major international airport with an active Chinese market garden in the middle of it? Well, we had it. And here are some of the Chinese ladies out tending the market garden crops right between the runways. This is airport land-leasing and, as fast as possible, we're stopping this. This, fortunately, is no longer there. A market garden with a lot of vegetable crops and vegetable refuse lying around is a magnet for birds. Until we got that place out of there we didn't sleep nights. Eventually, the lease was closed out and that was moved.

Here are hedgerows. A lot of our airports were formerly agricultural lands. They're really just a bunch of farms shoved together and a few runways laid down across them. And so you get hedgerows. Well, wonderful cover. What do you do about them? Well, get rid of them.

Let's try the next slide: Get your crews in, cut'em down; bulldoze the stumps out of the way and level the land. It may not look as pretty when you're finished, but it sure gets rid of the pheasants and the jack-rabbits and everything else that lives in hedge.

Let's try the next one: owls. Well, we've mentioned that small mammal populations attract owls. Now, it's possible to poison out small mammal populations in some areas, but in some places this is not too easy to do. We didn't even realize we had an owl problem at this particular airport until we had an owl strike, which cost a few dollars. Then we said, well, there must be a few owls here even though we don't see them very often. Let's find out. So we went into a trapping program and to our surprise, we live-trapped 300 owls from that field in a little over a year. We trapped them before they got on the runways and we haven't had an owl strike there since. We're just trapping them out as fast as they move toward the center of the airport.

This man (shown in slide), is the resident technician on that air-port, who deals with those problems. He has a whole series of live-traps that take these owls; and we're learning a little bit about owls. We band the owls and move them twenty miles away and turn them loose; they don't come back. Their cruising range isn't that far. I think we've had one or maybe two return.

There is a continuous infiltration of owls into that field even though the mouse population is now not very high; owls still move in on hunting expeditions and they want to perch on something. So we put out convenient perches, each equipped with a trap to take them by the feet with a piece of soft cord. It doesn't hurt the bird, and it takes him out of circulation before he gets in the way of an airplane.

We have one problem where the birds come to roost on the lights along the sides of the runways. We're dickering with the manufacturer of the runway lighting to see if he can make the lighting fixtures with a sharper point on the top so a bird can't perch. So, if you see an airport in Canada some day that has pointed-top lights along the runway, don't think it's crazy. That is where owls perch, and if they aren't able to perch there, they won't be near the runway. You've got to play every trick you know in this game.

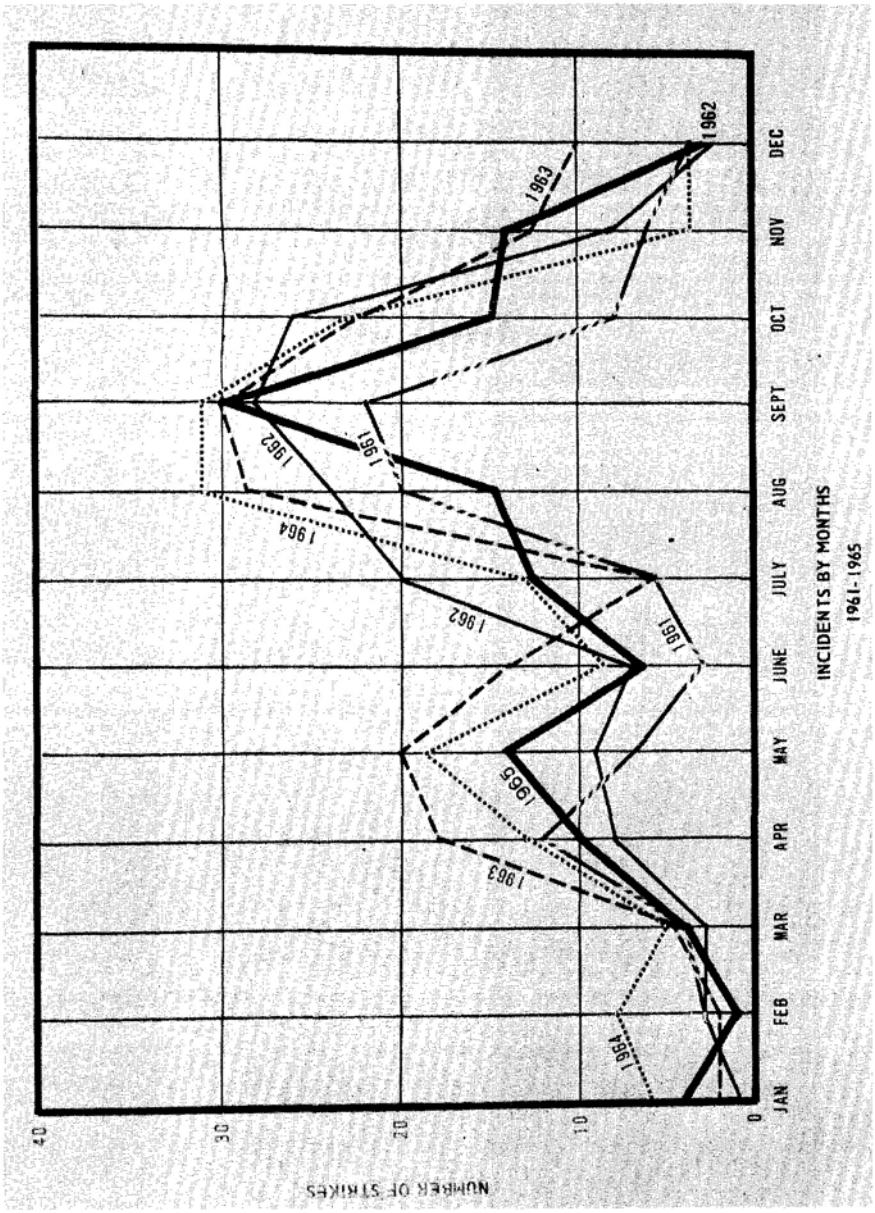
Next please. Well, we talked about bird nests in awkward places: swallow nests made of clay tucked up under the overhang on roof edges. Well, the way you beat this, of course, is, you put wire netting down diagonally across this on existing buildings. Then you have a talk with the architect and make sure that no more buildings are designed on the airport that have overhanging roofs. New buildings are coming up with flush-edged roofs where there is no place to put nests and the other ones, I think, have been screened since that picture was taken. We have up to 200 of these things on a single hanger in some cases. This can give you quite a concentration of swallows.

Next one please. Somebody is obviously going to bring up the

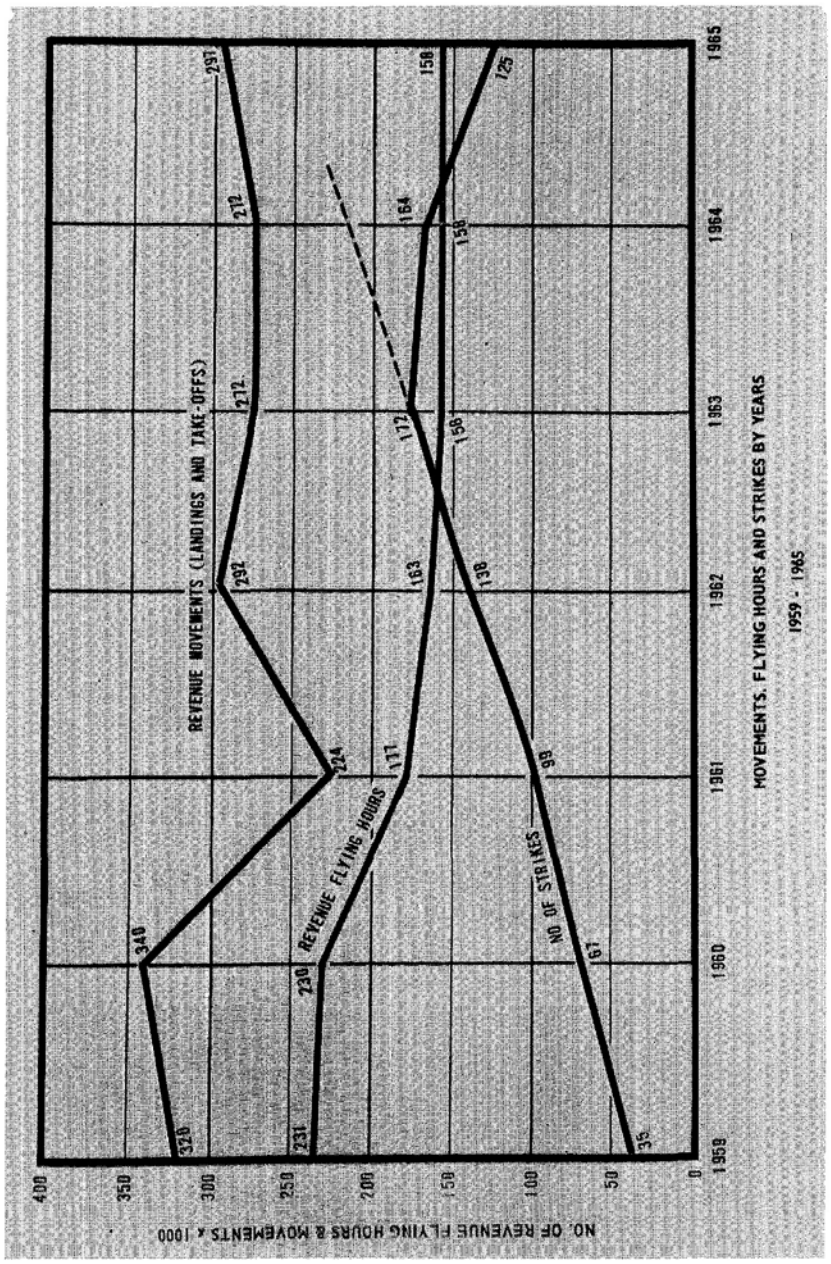
question of using trained falcons to drive birds away. All I can say is we've gone through this exercise twice now, using different methods of falconry. I can report to you with a perfectly straight face that if you have a dedicated falconer, and a series of healthy, well-trained falcons, during the hours of daylight, you can drive away from the airport, through the use of falcons, the birds that the falcons are trained to drive away. If you've trained them on gulls, they'll drive away gulls. They won't operate in heavy rain. They will not approach gulls, if the gulls are sitting on a wet runway, because a falcon apparently can't tell a wet runway from water and they're afraid of water. So they won't dive on a bird sitting on a wet runway. The gulls will just sit there and glare at them. Falcons are temperamental; they won't fly every day of the week, and when they're in a molt they won't fly at all. You have to have a fair stable of falcons to make sure you have a serviceable bird when you want him. And, they won't fly in the dark. Some wag suggested we cross falcons with owls and get some "night fliers." This didn't turn out to be very practical. If you have a problem during the day with gulls and you have falcons that are trained to attack gulls or to scare them away, it can work.

There is one field in Scotland now, a naval air station, that is using falcons to clear out birds and to drive them away from the field during the daylight flying exercises and they're happy with it. We went through the thing using, as I say, two different methods of falconry. We gave it a real good try at a couple of airports, one on each of the east and west coasts, and it works. But we think there are easier ways of dealing with emergent situations. Any time you get a number of birds on an airport, it's an emergency and you want to get them out of there as quickly as you can. You can use falcons, you can use sound equipment, you can use pyrotechnics, and a dozen other methods. What you want is something that you can just grab off the shelf with untrained staff and send them out to use. You can't do this with falcons, so we aren't about to recommend falcons very highly, except for this limited use.

Next please. Well, we talked about strikes. Here was Air Canada's pattern of strikes, up to 1963 (Graph 2). Suffice it to say that this trend, projected with 1964 data, shows about one hundred and sixty eight strikes. In 1965 it was back down here to 128 and for the first six months of 1966 it continued the downward trend. That was in the face of continuing operation of aircraft routes and passenger flights at essentially the same rate. In other words, the businesses continued uniformly but the strike rates are declining. Actually, the first six months of 1966 they put in, I think, 12% more aircraft, and 17% more passengers and the bird-strike rate is still going down (Graph 3). So, I think that we were sort of over the hump in 1965. Our habitat modification in terms of commercial airline operations is paying off because they have a lot of their strikes at airports.


INCIDENTS BY MONTHS
1961-1965
NUMBER OF STRIKES
0
10
20
30
40
JAN
FEB
MAR
APR
MAY
JUNE
JULY
AUG
SEPT
OCT
NOV
DEC
1962
1963
1962
1961
1964
1962
1961
1965
1963
1964

Graph 2.


MOVEMENTS, FLYING HOURS AND STRIKES BY YEARS
1959 - 1965
NO. OF REVENUE FLYING HOURS & MOVEMENTS x 1000
REVENUE MOVEMENTS (LANDINGS AND TAKE-OFFS)
REVENUE FLYING HOURS
NO OF STRIKES
1959
1960
1961
1962
1963
1964
1965
0
50
100
150
200
250
300
350
400
326
348
231
230
224
292
212
297
212
163
177
172
158
164
150
138
99
67
35
125

Graph 3.

Next please. This is just a comparison of different airports. This brings up the question that is uppermost in any bird control program and that is motivation of the staff doing the work. If you have a staff that is really interested in solving this problem and isn't just sitting back saying there is nothing we can readily do, they really get out there and work, all of them, all of the time. That way you can bring the rate down. One of our better airports in this is Montreal where the rate ran along pretty constant and it's now trending down. They've cleaned that airport up a lot. You'll see some airports on this graph, and I won't stress them particularly, where the rate hasn't gone down, and I can tell you that one of the reasons it hasn't gone down is that the people there are not working at it. I've talked to my opposite numbers in the military service and they tell me exactly the same thing. On the military bases where the base commander decides that this is going to be done, and the word gets out, it gets done. And where the base commander is worried with other troubles and not putting too much emphasis on this one, the problem doesn't get solved. So, motivation of the people that are involved is a very big part of this thing in getting results.

Next please. Well, I mentioned other methods of scaring. You can go out with sound trucks and play distress calls and alarm cries. This will work, but it isn't very quick. Any of you who have used this technique on gulls know that when the gulls rise the first thing they do is go over to the sound truck to see what's happening. After they've circled around for awhile, they finally get the message that whatever's happening they're not about to stay around and see it, and finally they go away. But it takes ten minutes or so for all of this to happen. In the meantime, you may have had to hold a bunch of aircraft up in the circuit while you're getting the gulls out of the way. In our experience, it's far quicker to go out with a handful of shell-crackers and boot them out that way.

They get the message a lot quicker and they don't come over to see what the guy's shooting at; they know, and they get out of there. So, for emergent problems we favor other methods, but in some cases I'm not about to run this method down. It works, but it takes longer, that's all. You have to have quite an outlay of equipment to do it.

Next. I talked about alternative kinds of ground cover. This is a slide of low ornamental plantings of low-growing shrubs which are used on streets in some places. That's not a very good slide, but I merely threw it in to remind you that grass isn't necessarily the best answer. We're looking in two different parts of the country for other plants that may have promise for ground cover.

This shows our radar network. Those are the locations of the stations and roughly the radius of action where you can see birds on the radar scope. And, as you can see, we didn't have complete coverage, but we looked at something like 150,000 square miles of the country

on a continuous basis for several months and we learned a lot. Of course, we haven't got all of the films analyzed yet. We have three, three-man crews analyzing the film and it's a pretty time-consuming job. We are going to code all of this stuff for computers and then match it to the computer data on weather to see how good the correlations are. There probably are correlations in it that we have not yet worked out, but we've already gotten some leads that look pretty good for forecasting bird migration intensity, times, and related matters. Well, thank you very much. If you have any questions. . . .

DISCUSSION

C. FAULKNER: You've heard the dissertations from the three panelists. Are there any questions?

F. GLEASON: I just have a thought about grass and weeds at most of the airports; I wonder if perhaps a covering of strong plastic might be the answer to prevent rodents and birds close to certain areas. I wonder if that might be of a little help, under certain circumstances.

DR. SOLMAN: In our experience, one of the early things we tried on members of our committee was paving the airport. Their first reaction to this was the cost and the second reaction was that the maintenance of it would be a tremendous problem, and third, the drainage from it. One of our problems on some of these wet areas that don't drain easily is that every time it rains, you get pools of water every place. Immediately, these are occupied by flocks of sandpipers and small birds of that sort which are, in themselves, a hazard. Whether we pave it or cover it with plastic or anything of that sort, you'd still have this drainage problem. Maybe it's worth a try. I wouldn't knock it all.

J. DILL: Have you tried the use of soil sterilants and then maybe covering the area with large enough aggregates of stone so that the grass wouldn't grow and you'd have drainage and so on?

DR. SOLMAN: We've been considering puting in a boulder field with big enough rocks that a jet wouldn't pick them up. We've been getting some consideration of this and the engineers are trying to work out estimates of cost for the areas involved.

C. FAULKNER: Then you'd bring in terns.

DR. SOLMAN: We've done it at one airport already. This is right. Well, we've said before: you cure one problem and maybe you create a

worse one. But we're willing to try just about anything.

B. BRINK: Have any elements of the air force requested any information from you people as to when these migrations are about to take place? Has there been any exchange on that at all?

DR. SOLMAN: You mean the United States Air Force? Not in that form exactly, but we have had discussion with some people at meetings such as this where the matter has been talked about. I don't know what the internal arrangements are like, or how far the U.S. Air Force has gone in its thinking about dealings with this matter. I can say that we are ready to talk to anybody at any time.

B. BRINK: So, in the event that somebody got in touch with you and said, "Look, we want you to alert us when we're going to need help or something. . . . "

DR. SOLMAN: We could do this now in some areas. We could give information, now, in the fall of the year particularly on goose movements out of James Bay. We could give them some advanced information and say, "This is the night they are coming. They are already in the air and they're at point "x" and they're moving south at 55 knots. They'll be over you in so many hours." This we could do now.

J. STECKEL: How about night flocks? Do you have any data on hours of night flights?

DR. SOLMAN: Well, most of the bird migration that I am talking about is night.

J. STECKEL: Hours of night flight? Is this all night or . . . ?

DR. SOLMAN: No, well, it depends on the species. We know more about geese than we do about most things. In the James Bay area, for instance, where they concentrate before they move in their major moves in the South, they start off exploring the situation before sunset, in the last couple of hours of daylight. By sunset, they've made up their minds that either this is the night they're going to go south or that this is a good night to go back and sit on the mudflats and feed or just sit. They make a lot of exploratory flights for maybe a week or ten days before they actually push off south, as near as we can tell. On the night they decide to go they leave the southern edge of James Bay somewhere between six and eight o'clock, and that puts them across our major Air Canada route about 11:00 at night. In some cases they'll push right on through to the Gulf coast, 30 hours non-stop. So you may have them flying all night and the next day and a part of the second night before they

get where they're going. So they go 1700 miles non-stop, and they lose a pound and a half of weight doing it, and when they land they are pretty tired. In some years, they're not in very good shape to start with. Perhaps they had a tough season on the breeding ground and they're not tanked up to go that far. They may fly 700 or 800 miles and then have to land and feed for a few days (load up some more fuel) before they can make the rest of the journey. We can forecast this now by looking at the physical condition of the birds on the breeding grounds on Baffin Island in June.

C. FAULKNER: We don't have the same problems Canada has now as far as waterfowl is concerned. These waterfowl come south so far, and then they start peeling off; they go east and west and south. We have had little blackpoll warblers, 24 million in the air during ten hours picked up on radar over Boston, Massachusetts. You're talking about a number of birds and different species. With most of our military aircraft (the one's I've been involved with--F-102's, F-104's), laughing gulls and starlings or herring gulls are problems because many military airports are on both coasts; so where Canada has its major problem in large birds, the geese and the four-pound waterfowl, ours is the small tight-flocking bird. I think of many airstrikes on the red-bellied sandpiper and these types. We're talking about mass, now. He's talking about one big animal; I'm talking about several small animals. Still the same amount of mass. Canada's problems at the airport are the same as ours, but the species of birds are somewhat different except for the herring gull. It's the only thing we have in common.

DR. SOLMAN: This is right.

DELEGATE: What structural characteristics of the Electra made it susceptible to airstrikes? What is the nature of it?

DR. SOLMAN: Well, all I know about Electras is that they're using an Allison engine that has a screen over the intake. The screen is of such dimensions that a few starlings with their wings spread out would block off the airflow into an engine. And as I understand from the reports I've seen, that was the cause of the power loss that brought that aircraft down. On the turbo engines of comparable power that are used on commercial airlines, some of them have screens and some of them don't. On one without a screen there would be a fair chance that starlings, being the size that they are, would go on through and get chewed up. You might have some damage but you wouldn't have a complete power loss. That's only my personal opinion for what it's worth.

We know in our own turbine aircraft fleet in Air Canada that some kinds of engines are very susceptible to bird damage and other kinds just chew them up, spit out the pieces, and go right on. On our

Viscount aircraft we don't pay any attention to bird strikes as such, if they're engine strikes. Because of the design of the Viscount turbo, you just get bird pieces left on the runway behind in a normal takeoff. We kill 25 gulls at a time on one Viscount takeoff and nobody gets excited--except the guy who has to go out and sweep up the bits and pieces. I'm over-emphasizing that. You worry about any of these because there can always be one that will hurt somebody. But, in fact, you can go through a flock of birds with a Viscount with minimum damage to the aircraft. But try to fly a Vanguard aircraft or some others through that same situation and you might have quite serious damage.

C. FAULKNER: Our NAFAC down in Atlantic City, New Jersey, are doing this type of work. They're doing the work on the test block, this four pound bird that they're talking about, projected at five hundred mph, figuring out structural stress. Also, they're doing the same thing as far as intake of birds into an engine block at maximum energy for takeoff and duplicating what could happen. As the doctor said, each aircraft motor has a different compression ratio, different types of buckets; some will bend and some will break. So each aircraft is designed in a little different way.

They have an excellent film duplicating the Electra crash where the engines ingested four species, four starlings, then eight starlings, then twelve starlings, and you can see exactly what happened to the Electra engine as this occurred. These films are available and would be quite a topic of discussion.

DR. DYER: Are there any data on the placement of rear-engine jets? This was an engineering design that was thought to, perhaps, cut down on strikes. Are there any data on this?

DR. SOLMAN: All we can say is that you can have strikes on rear-engine jets because there have been a number of strikes on the various kinds of rear-engine jets that are flying. On the VC-10 where you have pairs of rear-engines mounted side by side, you can compound the problem because when a bird hits one engine and it breaks up, the pieces fly out the front and go back into the second engine and you lose both engines on the same side. This has been done. We can't really compare the strike rate on the rear jets with the front jets because to do this you would have to have aircraft of those two types flying the same routes at the same times in the same geographical area, and at the moment we don't have this, so we can make a valid comparison. On the face of it, you would think, since a lot of your airline strikes are on landing, that the flaps being down would give you some protection on a rear engine. I can say that one BOAC going into Bombay, picked up a seven or eight pound raptor that was cruising around quietly and took

out both engines on the same side. Nobody got hurt, but I don't think they were all that happy about it.

B. BRINK: Are you, Ki, on speaking terms with your fish colleagues who are interested in raising fish for farm ponds? And so on what basis do you recommend chlorinated hydrocarbons in high concentrations?

C. FAULKNER: Let's go back. I hope I made the point clear. We use chlorinated hydrocarbons only when it has no effect upon the environment outside the airport. I hope I made this clear because we aren't about to contaminate the countryside. We'll use some other method of control of the environment before we go to this extent. But there are many cases where we can use chlorinated hydrocarbons to take care of Japanese beetle control, and we know full well that it will not percolate into the water course because it has too far to go and the chlorinated hydrocarbons tie up closely to the soil particles. Unless you get silting, it would not be a problem. There are some places where we can use chlorinated hydrocarbons safely.