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BIRD IMPACT TEST ON JET ENGINE – ANALYSIS

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Abstract: This project deals with the bird strike in the jet engine which causes the engine failure and damages to the aircraft components. Bird strike is the common issue in the air transports. The collision of bird to the aircraft engine will cause substantial losses to the aircraft industry in the way of damage, delay of flight and cancel of flight etc., this makes an issue in the aviation industry. But nowadays the relative cause goes high. In order to reduce the bird strike, pre-determine the issues and relative measurements of the causes and the solutions to be resulted by this project. Here the techniques used to reduce the bird strikes are reviewed and the adequate measures are analysed by using ANSYS software and the engine is designed by catia-v5 and the precautions are clearly described.

Keywords: Bird, Jet engine, Measurements, aviation industry.

Introduction

We call collision between a bird and aircraft “bird-strike events,” and they are quite common and dangerous. According to the Federal Aviation Administration (FAA), wildlife strikes cost the U.S. civil aviation industry over $300 million and more than 500,000 downtime hours each year. Also, people’s lives have been lost or being in risk due to aircraft malfunctions after bird-strikes which make it imperative to design aircraft components capable of withstanding these impacts.To obtain certification from the FAA, an aircraft must be able to land after an impact with a bird weighing 17.79 N (4lb) at any point in the aircraft. For new jet engines designs, the FAA certification requires tests for medium and large bird ingestion. For the medium or flocking bird requirement, an engine must be capable of operating for five minutes with less than 25% thrust loss after impacting several birds weighing 6.67 N (1.5lb) or 11.12 N (2.5lb). For the large bird ingestion test, the engine must be able to ingest a bird weighing 26.69 N (6 lb) or 35.58 N (8 lb) and achieve safe shutdown. These tests take hours of planning to execute and cost millions of dollars to the jet engine manufacturing companies.

Bird Strikes

Rare

Bird strikes are rare occurrences. Most pilots will pursue their career without encountering a significant bird strike events (“Significant” in terms of damage and risk to the aircraft.) Serious bird strikes are measured in occurrences per million flight hours. Historical records accumulated in the 1970’s showed that about 95% of all bird strikes to USAF aircraft were at bird weights of less than 4 pounds (1.8kg). Reported bird strikes with non-USAF aircraft showed similar trends. So, the probability of encountering a bird of significant size is rather small. More recent analyses of operational statistics show an increase in this weight to 4.5 to 5 pounds (2.0 to 2.3 Kg). Two factors are believed to be contributing to this. One is a trend to conduct low-altitude flying in corridors where noise will be less objectionable to local civilian populations. This results in increased use of corridors that are likely to be populated with large birds. The other factor is the increasing populations of these large birds.

Costly

A significant bird strike, while rare, can be very costly. The USAF experiences about 3000 bird strike per year. These bird strikes results in a loss of about 1-2 aircraft per year and loss of about 1-2 aircrew members every 3-5 years. USAF costs for bird strike damage are about 50 million US dollars per year. However, the above numbers are for average years, and the cost in dollars is MUCH larger in the years where one of the lost aircraft was a large aircraft (B-1 in 1987, E-3 AWACS in 1995). When the aircraft has many people on board, the cost in lives can also be large. Costs due to bird strikes encountered by the worldwide aviation fleet are estimated at over three billion US dollars per year. A large portion of those costs are associated with canceling commercial passenger flights and arranging alternative flights/aircraft for the passengers. The costs associated with the impact damage are a function of several primary variables Bird weight, number of birds, impact speed, and impact location on the aircraft, phase of flight when the bird strike occurred, and the effect of the damage on the aircraft's ability to fly and to land safely.

Predictable

While bird strikes are rare, they are predictable as are the consequences. The aircraft flight path sweeps through a given volume of airspace. Birds have seasonal as well as daytime and night time population distributions within this airspace. Birds also have a probability distribution by weight. Some bird species tend to be encountered as single birds, while strike with other bird species typically involves flocks of birds. The probability of collision with a given weight bird is therefore predictable, and the probability that those collisions will involve flocks of birds can also be estimated. The aircraft time and speed in various altitude bands can be predicted for a more precise estimate of the range of probable impact weight and speed conditions. The probable impact location on the aircraft is closely related to the projected frontal area of the components of concern. While these areas vary with different types of aircraft, a nominal distribution of bird strikes as shown in (**Figure:**2). By the USAF from 1989 to 1993 is as follows

Engines	44%
Wings	31%
Windshields	13%
Random	16%
Fuselage	4%
Multiple	11%
Nose	4%

Analytical tools for predicting both the probability and the structural consequences of a bird strike are available to those pursuing this task. The tools for predicting structural consequences are also becoming sufficient for use in designing components to tolerate such bird strike energies. Some of the work being done by the International Bird strike Research Group is also creating computerized models of bird flocks that can be used in conjunction with other software to assess the likelihood that a particular aircraft/bird flock encounter will produce significant damage to multiple aircraft components (example two or more engines with one bird strike event).

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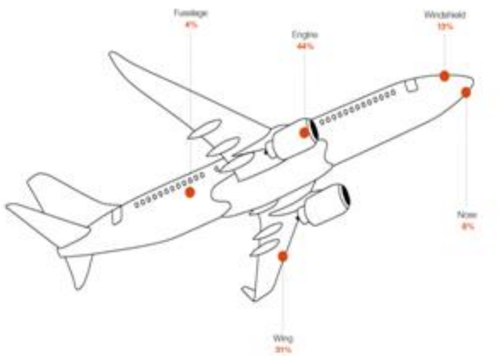

Figure: 1 Impact location on the aircraft

Reducible

Bird strikes cannot be eliminated but the probability of occurrence can be modified to the benefit (or the detriment) of the aircraft and crew. Information is available on habitat modifications in the vicinity of the airfield to result in either increasing or decreasing bird populations. For example, controlling vegetation height near the runways can reduce attractiveness to birds, and allowing landfills or standing water near the runways can increase the attractiveness to birds. Falcons, bird distress calls and noise generators such as shell-crackers and explosive gas cannons are available for control of airfield birds. Excellent sources of expertise in the US on habitat management include the USAF Bird Aircraft Strike Hazard (BASH) Team and various experts in the US Department of Agriculture (USDA).

Three new approaches to bird strike reduction are discussed below.

1. The first approach involves active deterrence of bird activity from the aircraft flight path, using special soundsand "audible" radar to help birds notice aircraft sooner and get out of the way. Laboratory tests have determinedwhat modulations can be added to radar that will allow birds to hear the radar, and have identified types of soundsthat get the desired bird reaction of looking around for the sound source. Research has shown that while birds areinsensitive to ultrasound, or sound at frequencies above that heard by humans, they do detect infrasound, or sound atfrequencies below that heard by humans. Under laboratory test conditions they respond to this sound in a mannerindicative of visually searching for a source. This would cause the birds to look around for the sound source andthis would increase their opportunity to see and thus avoid the aircraft.

2. The second conceptual approach would use aircraft radar to detect birds on a collision course with an aircraft inflight and advise the pilot how to avoid the bird with a gentle maneuver.Radar tracking of birds has long been a tool used by ornithologists in their studies. However, most aircraft radarsand ground-based radars consider the radar returns from birds as unwanted clutter. These radar systems typicallyfilter out and discard bird data. The new concept being pursued create a “detect birds/warn pilot” system thatwould use bird radar return data and process it in combination with aircraft flight path information through anartificial intelligence network to predict bird strikes that are about to occur. For those that have a high probability ofbeing a serious incident the aircrew could be given a warning to take evasive action.

3. A third concept would use various sensors (radar, visual, IR, etc.) plus some computer software that woulddetect birds, recognize what bird situations posed a significant risk (birds on or near runways), and advise airportpersonnel so they could take appropriate actions to reduce the bird strike risks.

Objective

The objective of this report includes a realistic finite element bird model to investigate what effective curvature, of an aircraft engine, has on the impact response due to bird strike. This study assesses the requirements and level of the protection afforded in meeting current risk from increased bird size, increased populations and flocking behaviour. While the incidence of strike related mortality between birds and aircraft engine is well documented there has been a limited amount of attention placed upon prevention. The purpose of this review is to analyse the many strategies related to bird exclusion and strike minimization utilized in variety of disciplines to determine those best suited for applications. Furthermore, the research required to effectively deploy a given strategy is discussed. In the creation of this analysis it became apparent the bulk of bird control knowledge and research does not reside within the realm of conservation and ecology. The aviation industry in particular has engaged in a great deal of research focused on minimizing bird strikes at airports where the safety and financial repercussions can be severe. Although many of the techniques found at airports are difficult to translate to a suburban setting (propane canons, flares, active shooting, etc.) there are a number of techniques that appear to be applicable. Bird control within an industrial and is also well research and developed, but like aviation related methods, relevant techniques have largely gone unnoticed and unapplied within the realm of architecture.

Scope

We call collision between a bird and aircraft "bird-strike events," and they are quite common and dangerous. According to the Federal Aviation Administration (FAA), wildlife strikes cost the U.S. civil aviation industry over $300 million and more than 500,000 downtime hours each year. Also, people's lives have been lost or being in risk due to aircraft malfunctions after bird-strikes which make it imperative to design aircraft components capable of withstanding these impacts.To obtain certification from the FAA, an aircraft must be able to land after an impact with a bird weighing 17.79 N (4lb) at any point in the aircraft. For new jet engines designs, the FAA certification requires tests for medium and large bird ingestion. For the medium or flocking bird requirement, an engine must be capable of operating for five minutes with less than 25% thrust loss after impacting several birds weighing 6.67 N (1.5lb) or 11.12 N (2.5lb). For the large bird ingestion test, the engine must be able to ingest a bird weighing 26.69 N (6 lb) or 35.58 N (8 lb) and achieve safe shutdown. These tests take hours of planning to execute and cost millions of dollars to the jet engine manufacturing companies. Due to this, it is very important to be able to predict damage caused by a bird-strike impact on engine designs to save money and time. In order to predict the damage of the components of a fan blade during a bird-strike event, we created a standard works in CATIA and ANSYS to model the blade and the bird. It allows us to model these events for its explicit solver and its ability to deflect the bird on the engine.

Bird Strike Prevention

Birds constitute a significant hazard to aircraft. The vast majority of bird strikes occur within five miles ofan aerodrome. There is no easy method of eradicating birds from an airport, but a comprehensive birdstrike prevention program (BSPP) is effective in reducing their impact.The key element of a good BSPP is the establishment

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of an effective wing/base bird and animal controlcommittee.The aim of any BSPP is to minimize bird hazards to aircraft operating from the particular field. The BSPPmust include at least the following four objectives

• Management of the environment;
• Dispersal of birds;
• Education of the aircrew; and
• Reporting of bird strikes and bird sightings.

Bird and Debris Deflector

A retractable deflector serves to deflect birds and debris from an air intake duct of an aircraft jet engine. The intake duct has a central longitudinal axis and a forward opening for the receipt of air. The deflector includes a plurality of elongate first support members disposed on the air intake duct in spaced relation to each other and having leading ends which extend from a perimeter of said forward opening. These members are mounted for movement to extend and retract the leading ends. A second support member is coupled to the leading ends of these first support members to retain said leading ends in spaced relation. The second support member is extendible in length and conFigure::d to hold the leading ends of the first support members sufficiently close together to cause said first support members to deflect at least one of a bird and debris, when in a first, deployed position, and to allow the leading ends of the first support members to maintain a spaced-apart relation along a line which approximately corresponds to the perimeter of the air duct when in a second, retracted position.

Background of The Invention

Large sized debris which enters the intake of a jet engine may have disastrous consequences, including engine damage, functional engine destruction, and, if all or most engines become non-functional, emergency termination of a flight. This is what occurred on Jan. 15, 2009 with a flight out of LaGuardia Airport which made an emergency landing in the Hudson River after both of its engines failed The source of damage was a flock of birds some of which entered the air intake of the engines, and rendered both engines non-functional.

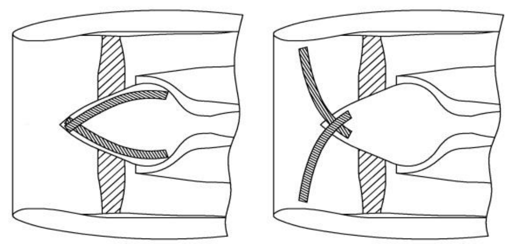

Figure: 2 Bird and debris deflector

Result and Discussion

It is a principal object of the present invention to provide protection to an operating jet engine against airborne birds and other debris which may damage the engine. It is a further object of the present invention to provide such protection using retractable apparatus, so that the aerodynamic consequences of such an apparatus are minimized, with respect to duration of use.The invention herein discusses methods and apparatus for preventing birds and other debris from damaging a jet engine. It entails the deployment of a radially distributed set of first elements in front of the engine air intake. During the process of deployment, the leading edges of these first elements converge as they are extended from the engine housing. In order to prevent these first elements from suffering damage or mal-positioning due to air turbulence, a second element, oriented transverse to the first elements, and positioned at the leading edge of the first elements, is also deployed. The second element features an adjustable circumference, allowing it to maintain the leading edges during the process of deployment, with the circumference changing as the length of the deployed portion of the first element changes. By this process **30-40%** reduction in damage to the aircraft engine occurs.

Conclusion

Through integration of aero-science and bio-science, there has been good progress in the development of new technologies to reduce the aircraft birdstrike hazard. Some of the new technologies will certainly prove to provide additional, non-lethal, weapons or tools for cost effective win-win solutions.
Decision makers within the communities represented by airports, airlines, aircraft operators (both military and civil), aircraft manufacturers, and others such as insurance underwriters, will have opportunities to drive the underlying investments necessary to evaluate possibilities and convert potential into reality. Achieving the potential payoffs in flight safety from bird strike risk reduction will only happen through the continued collaboration and cooperation of aero-scientists, bio-scientists, and resource administrators.

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