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REDUCTION OF RISK: A FLIGHT CREW GUIDE TO THE AVOIDANCE AND MITIGATION OF WILDLIFE STRIKES TO AIRCRAFT

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(1) **REDUCTION OF RISK: A FLIGHT CREW GUIDE TO THE AVOIDANCE AND MITIGATION OF WILDLIFE STRIKES TO AIRCRAFT**

Capt. Paul Eschenfelder, Avion Corporation, 16326 Cranwood, Spring, TX 77379 USA;
Steve Hull, Senior Accident Investigator, British Airways, P.O. Box 10, Heathrow Airport, Hounslow, England TW6 2JA

Each year the world's airlines lose between \$1 billion to \$2 billion due to wildlife strikes to aircraft. This is roughly the same level of loss as the carriers pay out each year for lost luggage. One US airline cites its losses at \$2 million a month due to engine ingestion alone. The last several years have seen both hull losses to air carrier aircraft and lesser damage caused by such actions as loss of control and runway excursions. Wildlife strike mitigation is a defense in depth: airplane certification/construction standards; action by airport operators to minimize wildlife on and around airports; standards/regulation development by authorities such as ICAO and national regulators. What is missing is affirmative action by airline operators to develop and implement policy which will aid in the mitigation of this risk. As the airline operator, through its employees, is on the tip of the spear with this hazard, sound avoidance and mitigation policies, detailing actions which may be taken by employees, should be implemented. This paper will detail common practices which will reduce/eliminate wildlife strikes or mitigate their impact.

Reduction of Risk: A Flight Crew Guide

Capt. Paul Eschenfelder – Avion Corp.

Steve Hull – British Airways

2006 Joint Meeting

Birdstrike Committee USA/Canada

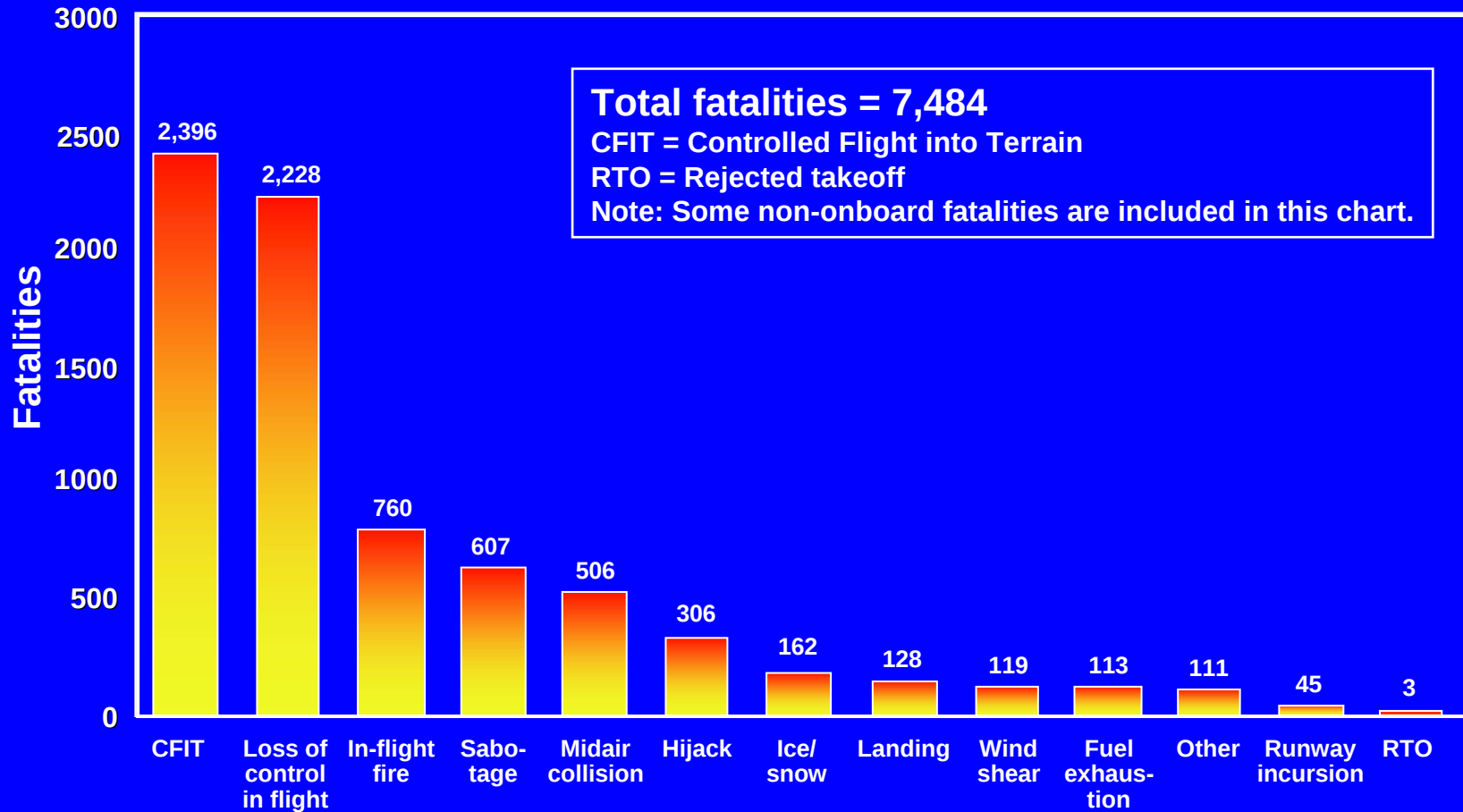
St. Louis, MO.

August 22, 2006

Costs of Wildlife Strikes

- US\$1-2 billion/year worldwide (similar to lost luggage cost)
- Over 190 people killed by collisions between their aircraft and wildlife since 1988

Types of Aircraft Accidents



The problem that safety officers face when trying to convince airlines that birds are a real and constant threat to aviation, a threat and hazard that can result in expensive repair cost to airframes and engines is, when reviewing the top ten reasons for recent aircraft accidents, bird strikes do not figure, so it appears to be a weak or inconclusive argument –

Steve Hull

British Airways

Past Accident Improvements

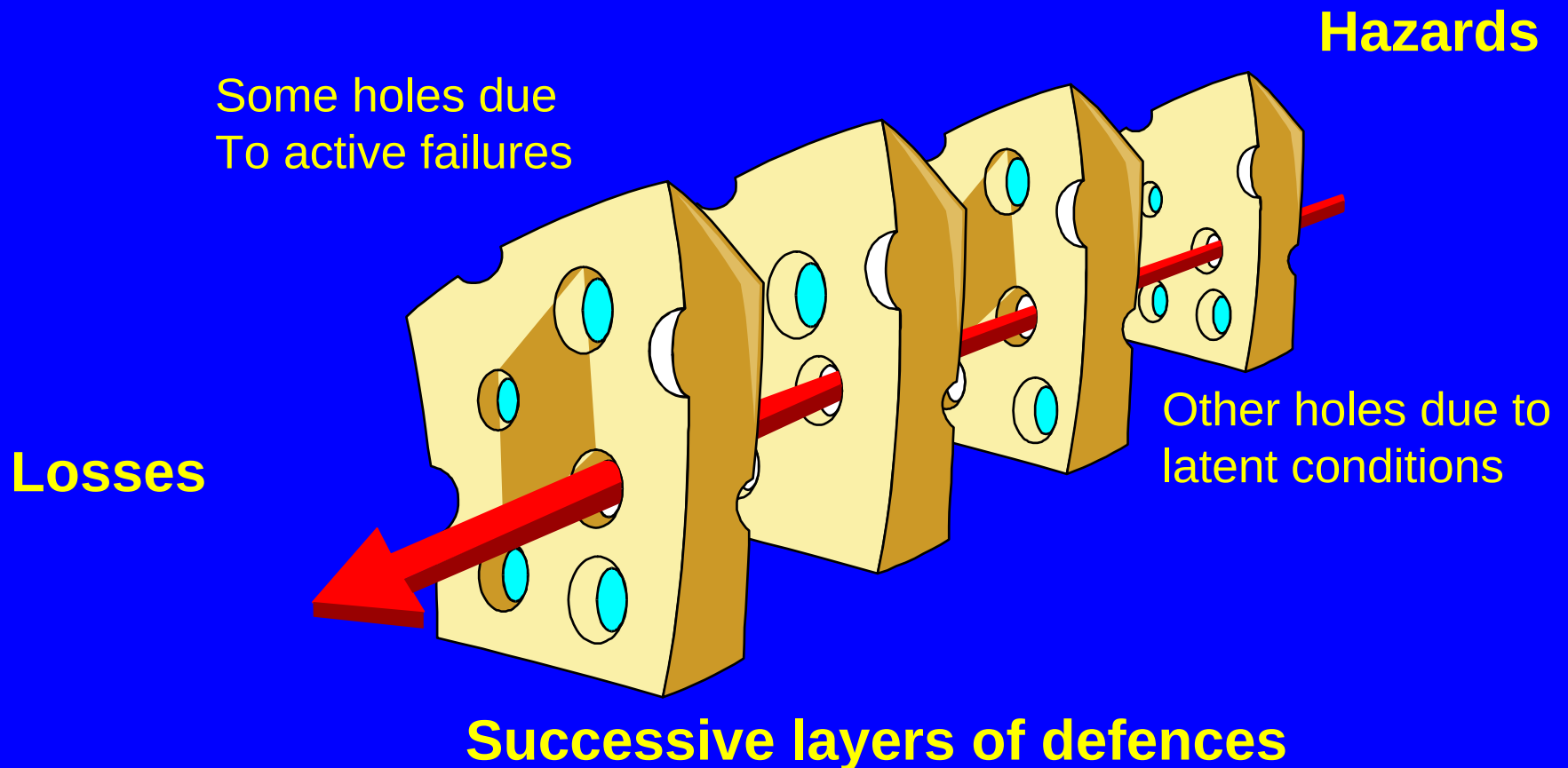


Future Accident Reduction

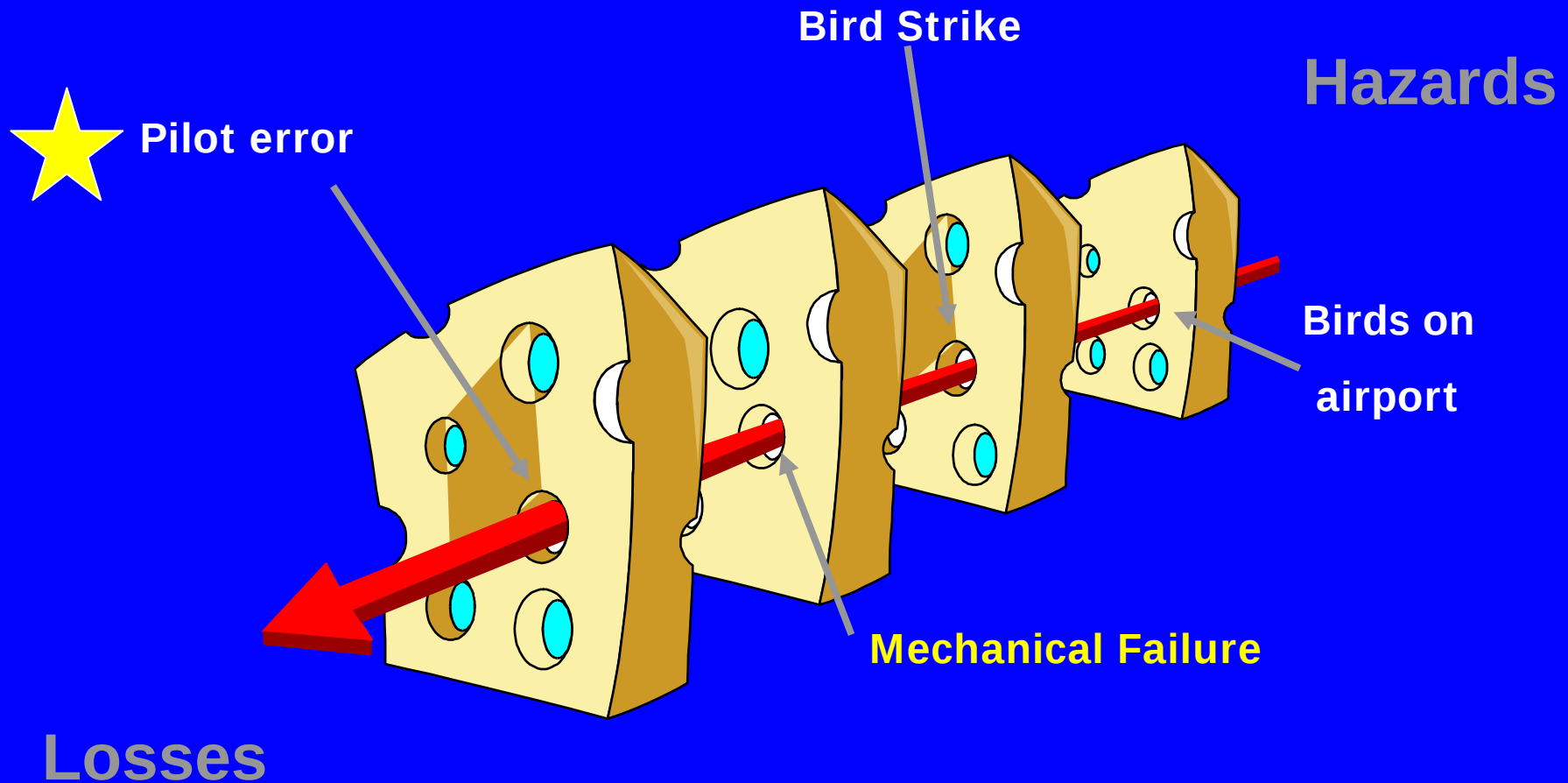
- In the future we must be proactive
- Must use risk management techniques to greater extent
- Identify and eliminate adverse trends
- Stop accidents before they happen

The 'Swiss cheese' model of organisational accidents

Dr. James Reason

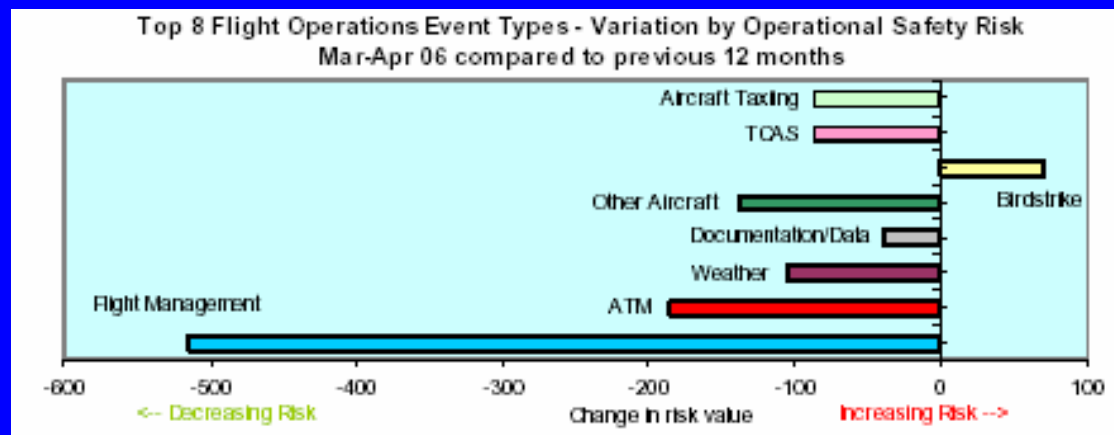
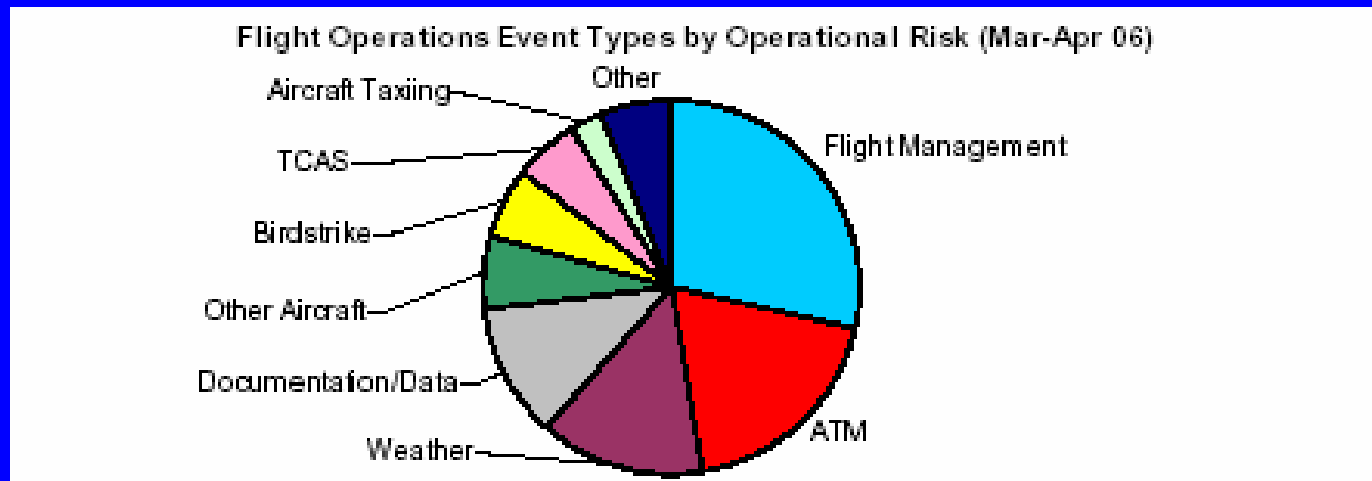


The 'Swiss cheese' model of an accident (Crash of SA 227 in Scotland 2002)



British Airways – Operational Risk

March-April 06



Hypothetical Bird Strike

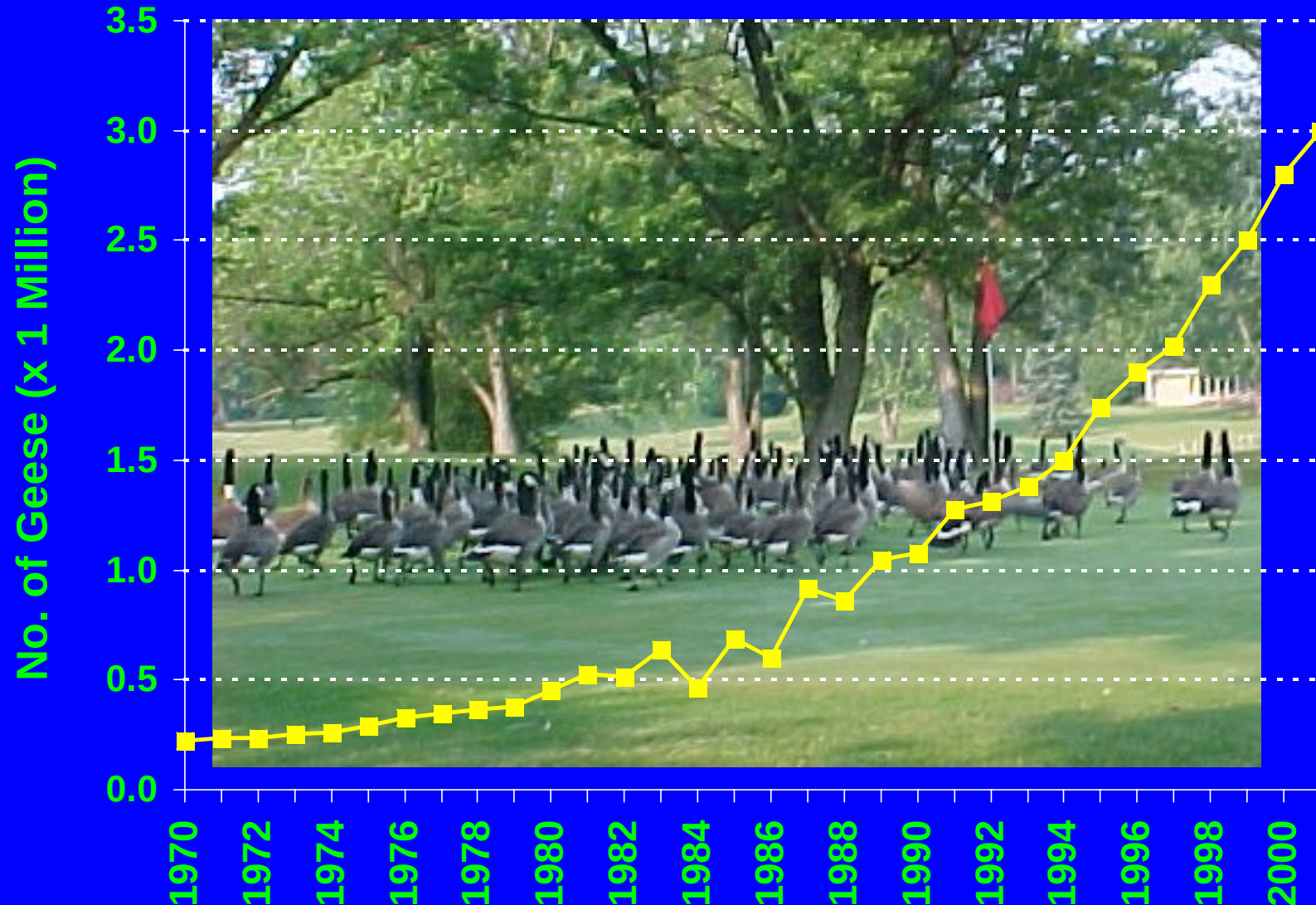


Risk Management - Severity high but probability can be mitigated

What's Needed?

- EDUCATION!
- CHANGE!
- Change in POLICY and/or REGULATION

RESIDENT (NON-MIGRATORY) CANADA GEESE IN NORTH AMERICA



Budgey-CSL-studies

- Three dimensional flock structure - 100" engine:
- Canada geese - 3
- Mixed gulls - 4
- Starlings - 9



B-747 engine-vulture ingestion-Nairobi

NEW engine standards are being implemented by JAA/FAA-but only for NEW engines



B-767 gull ingestion-Tel Aviv



MD-11 gull ingestion-Portland,Ore.

The 36 Bird Species in N. America with Mean Body Masses >4 lbs

Rank	Species	Mass (lbs)
1	Mute swan	26.01
2	Trumpeter swan	25.13
3	California condor	22.28
4	Wild turkey	16.31
5	Tundra swan	15.65
6	American white pelican	15.43
7	Whooping crane	12.84
8	Sandhill crane	12.78
9	Yellow-billed loon	12.13
10	Bald eagle	11.79
11	Golden eagle	10.83
12	Canada goose	9.22
13	Common loon	9.11
14	Brown pelican	8.16



(Species ranked
1-14, mean body
mass >8 lbs)

Composite rotating blades

DH-8 composite props vs. Canada geese during landing at Toronto –
both engines severely damaged



Aircraft Structures

- Design criteria is impact with *one* four pound bird at V_c
- Windshields are designed only to resist *one* four pound bird at V_c and not fail or spald
- Empennage is designed for *one* eight pound bird impact at V_c



**B-737 windshield destroyed by
goose impact over New York –
window spalled on impact
showering cockpit with glass**

B-767 encounter with flock of northern shovelers (17 hits including penetrations through wings, fuselage and radome) while climbing through 12,000 feet after departure from Paris to Miami, April 2001



Airport Birds

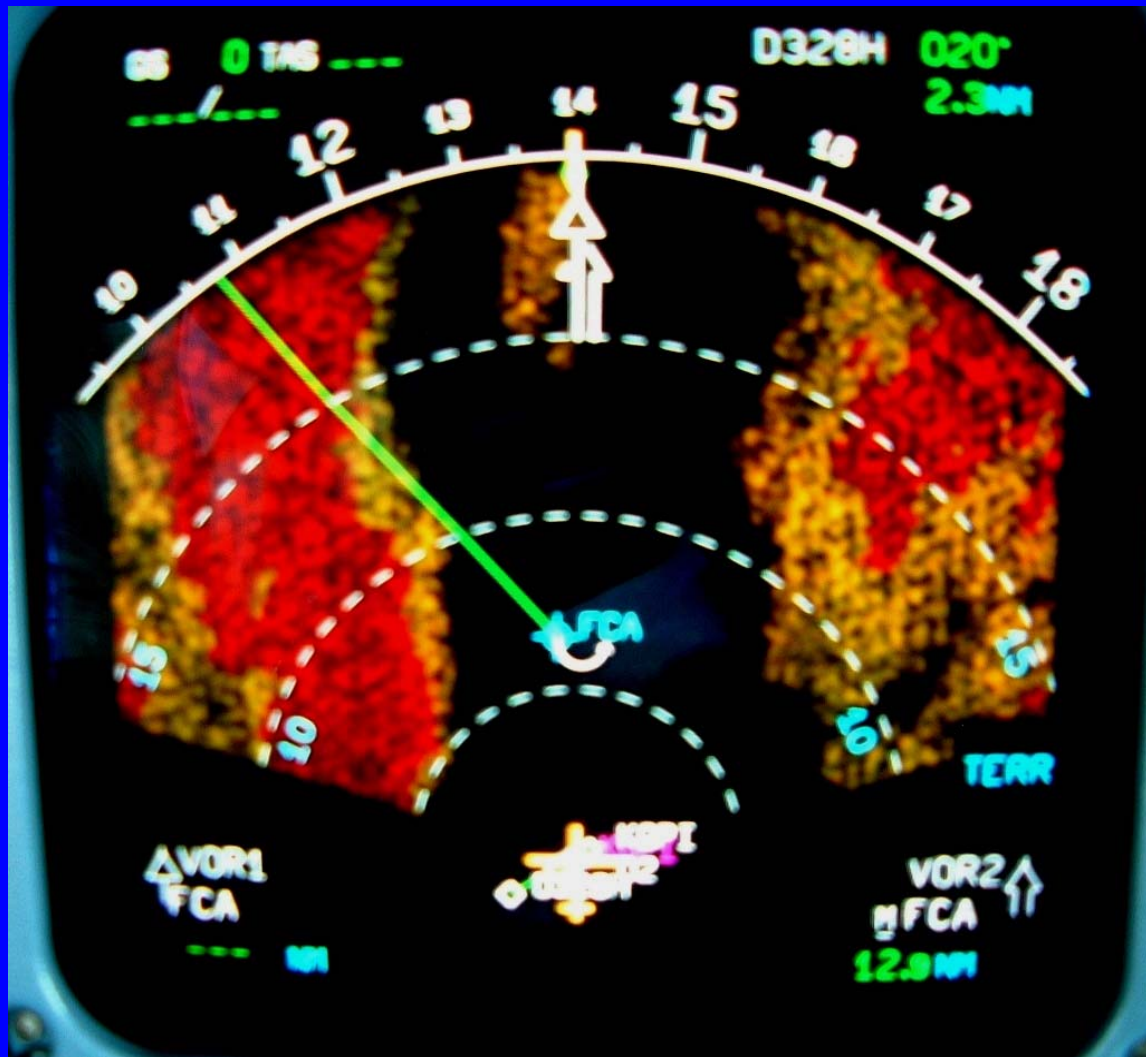
- Resident
- Non-Resident
- Fledgling
- How do we know?

Wildlife Hazards

- Part 139.337
REQUIRES Airport Operators to mitigate wildlife hazards
- ICAO SARPs updated to a *STANDARD* for wildlife mitigation



Is there a technical solution?



What doesn't work: Pilot Folklore

- Aircraft radar
- Jet engine noise
- Aircraft lights

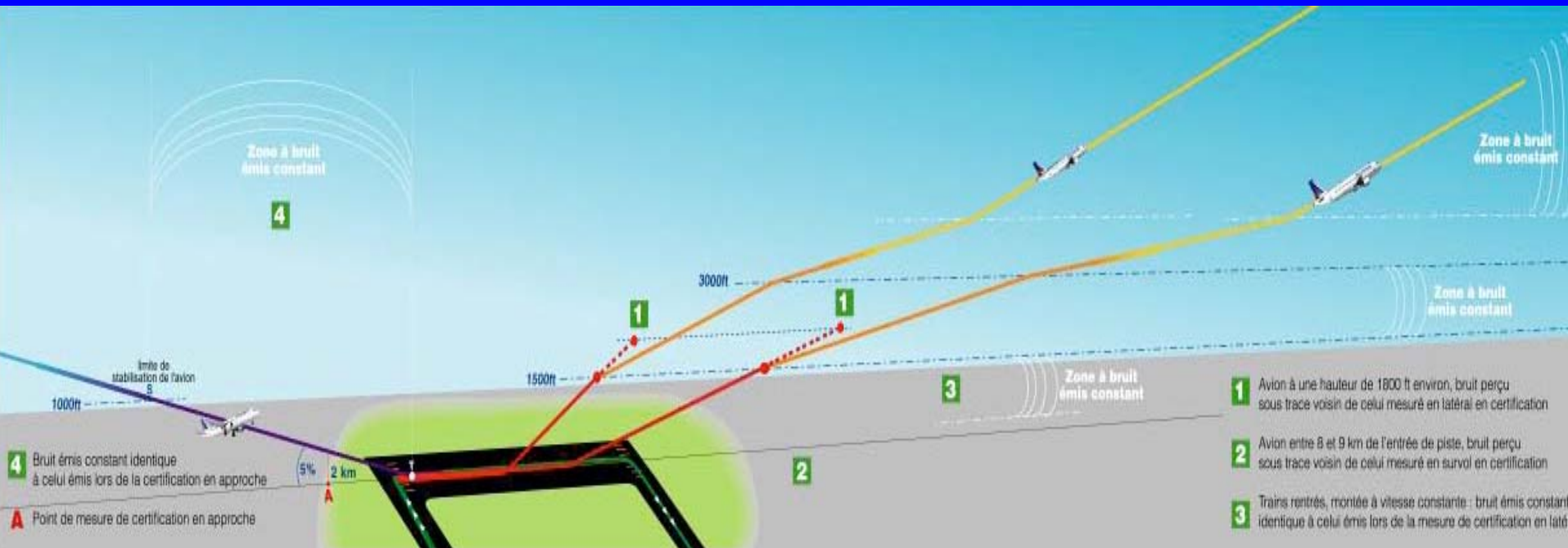
What does work?

- SIMPLE
- EFFECTIVE
- CHEAP

Don't takeoff/land!

- Same technique for other aviation hazards: windshear, poor braking, conflicting traffic, deicing, etc.
- Is safety first?

ICAO Noise Abatement Profile 'A' (VNAP 'A')



SLOW DOWN!

- $KE = [1/2 \text{ mass}] \times \text{velocity (squared)}$, e.g., *31% more energy transfer* with the same bird at 300 kias vs. 250 kias
- *Same applies to engines*



B-747 engine-vulture ingestion-Nairobi

NEW engine standards are being implemented by JAA/FAA-but only for NEW engines



B-767 gull ingestion-Tel Aviv



MD-11 gull ingestion-Portland,Ore.

Learjet vs. deer - Alabama

Dallas Cowboys Football
Club Learjet



Enroute – PULL UP!

- Birds will attempt to avoid the aircraft – if seen
- Birds may turn, dive but *do not climb*
- *Pull up* to pass over the threat

Report Hazards

 BIRD/OTHER WILDLIFE STRIKE REPORT																																																
U.S. Department of Transportation Federal Aviation Administration																																																
1. Name of Operator	2. Aircraft Make/Model	3. Engine Make/Model																																														
4. Aircraft Registration	5. Date of Incident Month _____ Day _____ Year _____	6. Local Time of Incident ☐ Dawn ☐ Dusk ☐ Night ☐ Day ☐ Night ☐ AM ☐ PM																																														
7. Airport Name	8. Runway Used	9. Location & En Route (Check One/Reference 4. Date)																																														
10. Height (AGL)	11. Speed (Kt)																																															
12. Phase of Flight ☐ A. Parked ☐ B. Taxi ☐ C. Take-off Run ☐ D. Climb ☐ E. In Route ☐ F. Descent ☐ G. Approach ☐ H. Landing Roll	13. Part(s) of Aircraft Struck or Damaged <table border="1"> <thead> <tr> <th></th> <th>Struck</th> <th>Damaged</th> </tr> </thead> <tbody> <tr> <td>A. Airframe</td> <td>☐</td> <td>☐</td> </tr> <tr> <td>B. Windshield</td> <td>☐</td> <td>☐</td> </tr> <tr> <td>C. Nose</td> <td>☐</td> <td>☐</td> </tr> <tr> <td>D. Engine No. 1</td> <td>☐</td> <td>☐</td> </tr> <tr> <td>E. Engine No. 2</td> <td>☐</td> <td>☐</td> </tr> <tr> <td>F. Engine No. 3</td> <td>☐</td> <td>☐</td> </tr> <tr> <td>G. Engine No. 4</td> <td>☐</td> <td>☐</td> </tr> <tr> <td>H. Propeller</td> <td>☐</td> <td>☐</td> </tr> <tr> <td>I. Wing/Rotor</td> <td>☐</td> <td>☐</td> </tr> <tr> <td>J. Fuselage</td> <td>☐</td> <td>☐</td> </tr> <tr> <td>K. Landing Gear</td> <td>☐</td> <td>☐</td> </tr> <tr> <td>L. Tail</td> <td>☐</td> <td>☐</td> </tr> <tr> <td>M. Lights</td> <td>☐</td> <td>☐</td> </tr> <tr> <td>N. Other:</td> <td>☐</td> <td>☐</td> </tr> </tbody> </table> (Specify if "N. Other" is checked)				Struck	Damaged	A. Airframe	☐	☐	B. Windshield	☐	☐	C. Nose	☐	☐	D. Engine No. 1	☐	☐	E. Engine No. 2	☐	☐	F. Engine No. 3	☐	☐	G. Engine No. 4	☐	☐	H. Propeller	☐	☐	I. Wing/Rotor	☐	☐	J. Fuselage	☐	☐	K. Landing Gear	☐	☐	L. Tail	☐	☐	M. Lights	☐	☐	N. Other:	☐	☐
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14. Effect on Flight ☐ None ☐ Aborted Take-Off ☐ Precautionary Landing ☐ Engines Shut Down ☐ Other: (Specify)	15. Sky Condition ☐ No Cloud ☐ Some Cloud ☐ Overcast	16. Precipitation ☐ Fog ☐ Rain ☐ Snow ☐ None																																														
17. Bird/Other Wildlife Species	18. Number of Birds Seen and/or Struck <table border="1"> <thead> <tr> <th>Number of Birds</th> <th>Seen</th> <th>Struck</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>☐</td> <td>☐</td> </tr> <tr> <td>2-10</td> <td>☐</td> <td>☐</td> </tr> <tr> <td>11-100</td> <td>☐</td> <td>☐</td> </tr> <tr> <td>more than 100</td> <td>☐</td> <td>☐</td> </tr> </tbody> </table>		Number of Birds	Seen	Struck	1	☐	☐	2-10	☐	☐	11-100	☐	☐	more than 100	☐	☐	19. Size of Bird(s) ☐ Small ☐ Medium ☐ Large																														
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21. Remarks (Describe damage, injury and other pertinent information)																																																
DAMAGE / COST INFORMATION																																																
22. Aircraft time out of service: _____ hours	23. Estimated cost of repairs or replacement: \$ _____	24. Estimated other cost (e.g., loss of revenue, lost assets): \$ _____																																														
Reported by (Optional)	Title	Date																																														
Paperwork Reduction Act Statement: The information collected on this form is necessary to allow the Federal Aviation Administration to assess the magnitude and severity of the wildlife-aircraft strike problem in the U.S. The information is used in determining the best management practices for reducing the hazard to aviation safety caused by wildlife-aircraft strikes. We estimate that it will take approximately 5 minutes to complete this form. If you wish to make any comments concerning the accuracy of this burden estimate and any suggestions for reducing this burden, send those comments to the Federal Aviation Administration, Management Staff, 600 15th Street, Independence Avenue, SW, Washington, DC 20591. The information collected is voluntary. Please note that an agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number. The OMB control number associated with this collection is 3120-0046.																																																

Summary

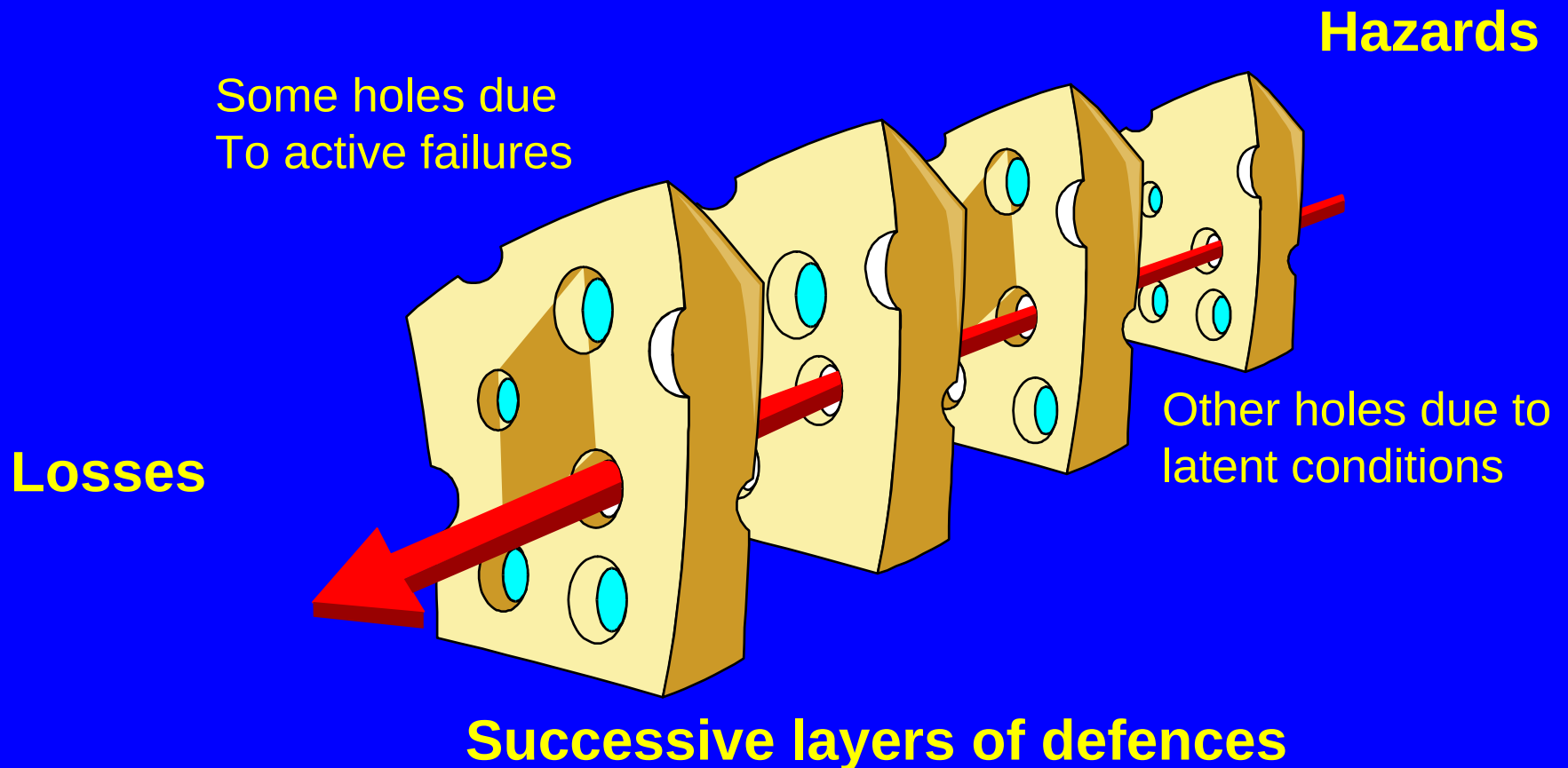
- Don't takeoff/land
- Pull up – enroute
- Climb above 3,000'
- No tolerance of large animals
- Slow down
- Report Hazards

Times change, Aviation Adapts

- Average strike cost = US \$244,000
- Pilots have a duty – but need the tools!
- Aviation safety is defense in depth

The 'Swiss cheese' model of organisational accidents

Dr. James Reason



Acknowledgements

- Bruce Mackinnon – Transport Canada
- Flight Safety Foundation
- Capt. Mack Moore - UAL, ret.
- USDA, FAA, TC

Questions?

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