AVIATION SAFETY

OUTLINE

- **Fundamental concepts**
- **Human factor in aviation safety**
- **Aircraft accident investigation**

Fundamental Concepts in safety

Accident vs. Incident

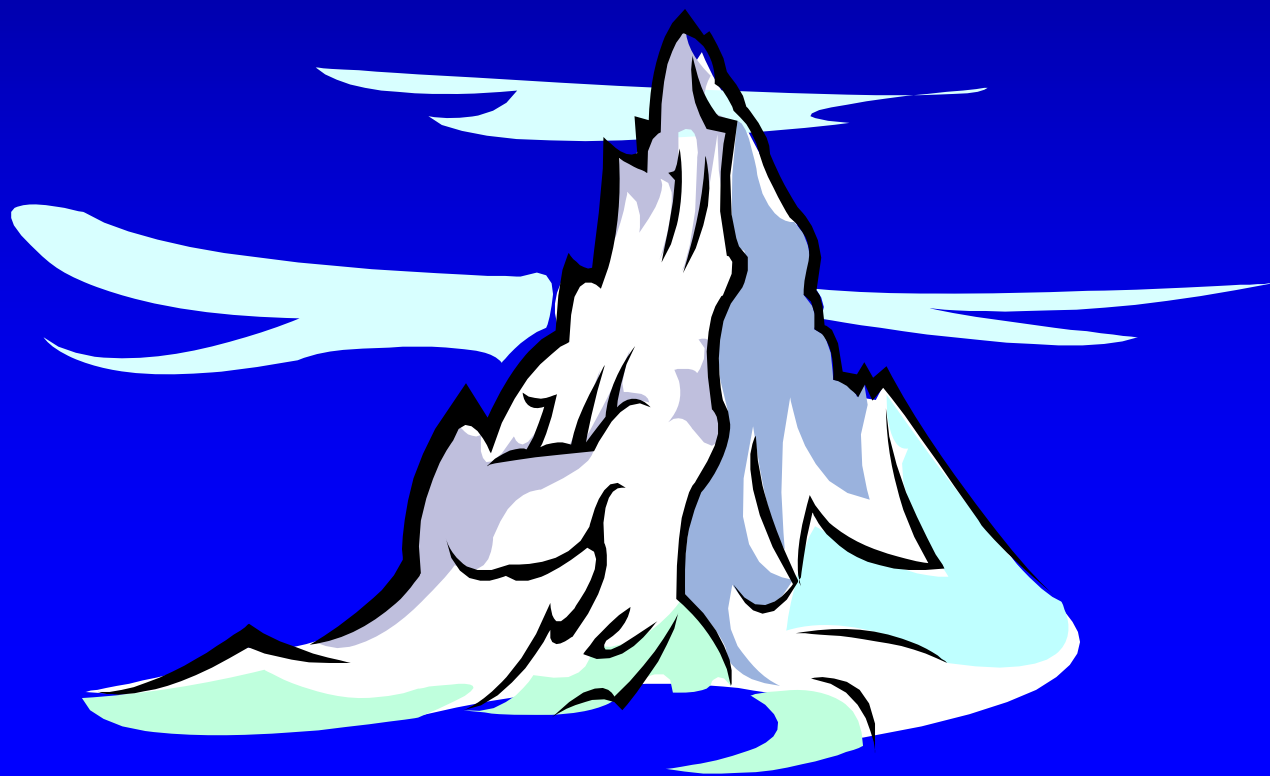
Aircraft accident – An occurrence associated with the operation of an aircraft and in which

- **any person suffers death or serious injury, or**
- **aircraft receives substantial damage.**

Incident – An occurrence other than an accident, associated with the operation of an aircraft, which affects or could affect the safety of operations.

Accident vs. Incident

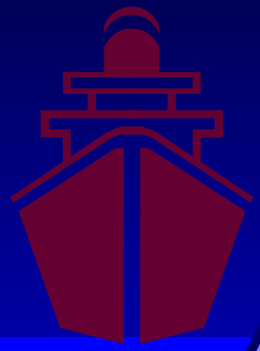
Minimum Safe Altitude (MSA)



Accident

Relation between accident & incident

The Heinrich Ratio



Example : Safety in Ground Operations

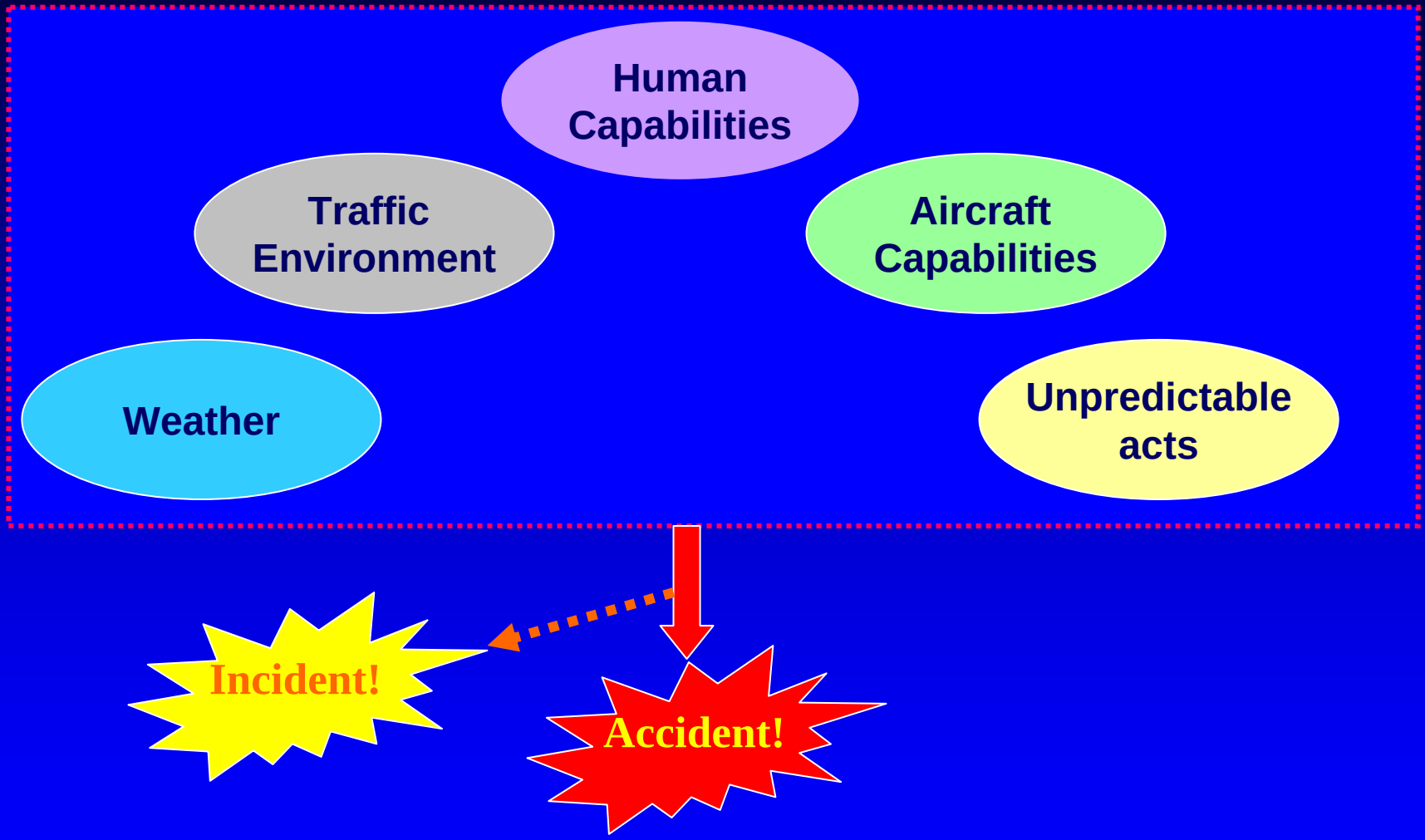
Sources of Hazards

- **Fuel**
- **Electricity**
- **Compressed gases**
- **Machine Tools**
- **Spilled oil and grease**
- **Tires**
- **Welding**
- **Running aircraft**
- **Foreign Objects**

Example : Accident at Ground operations (Running Engine)

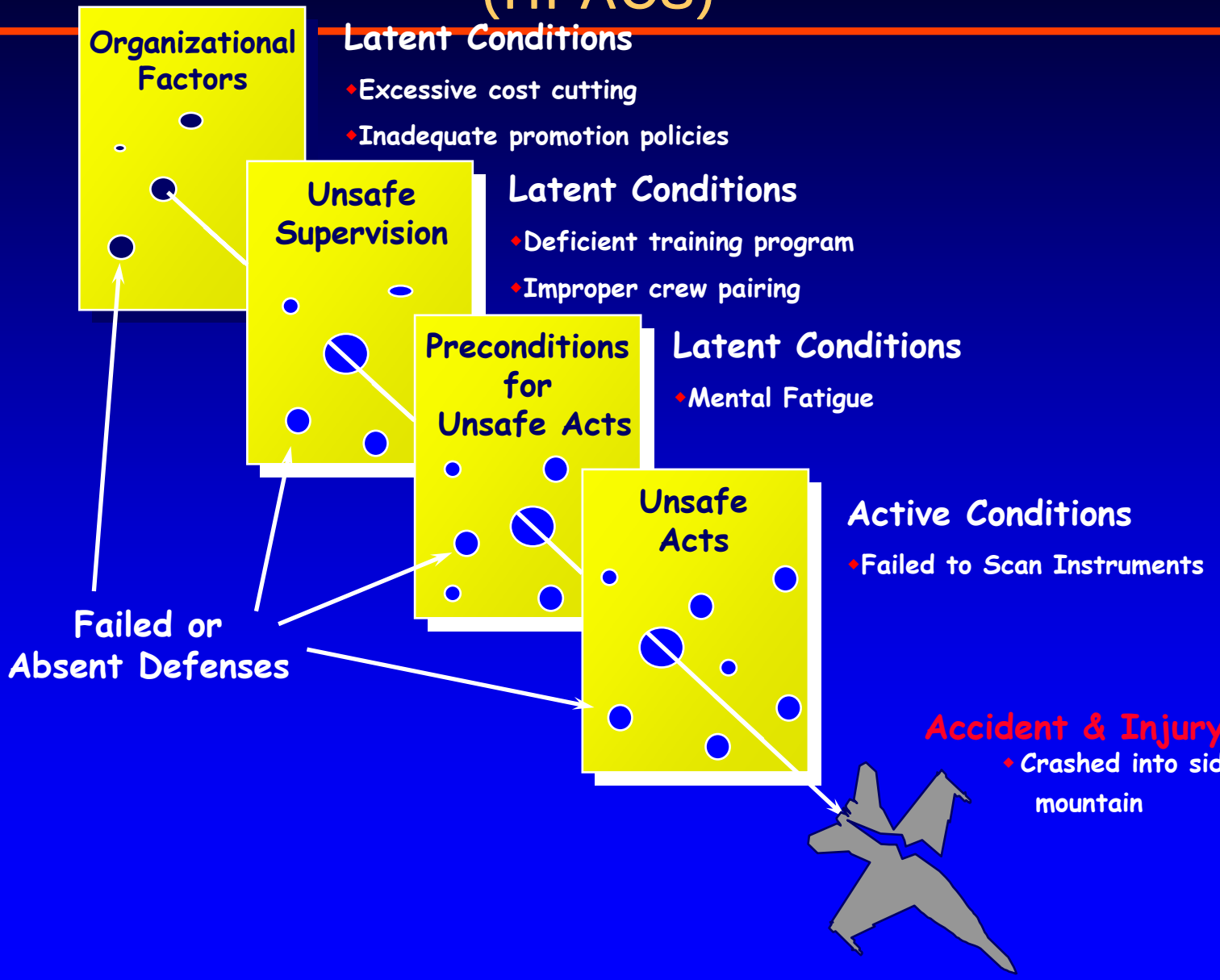
Example : Incident in flight

Primary Accident Causes

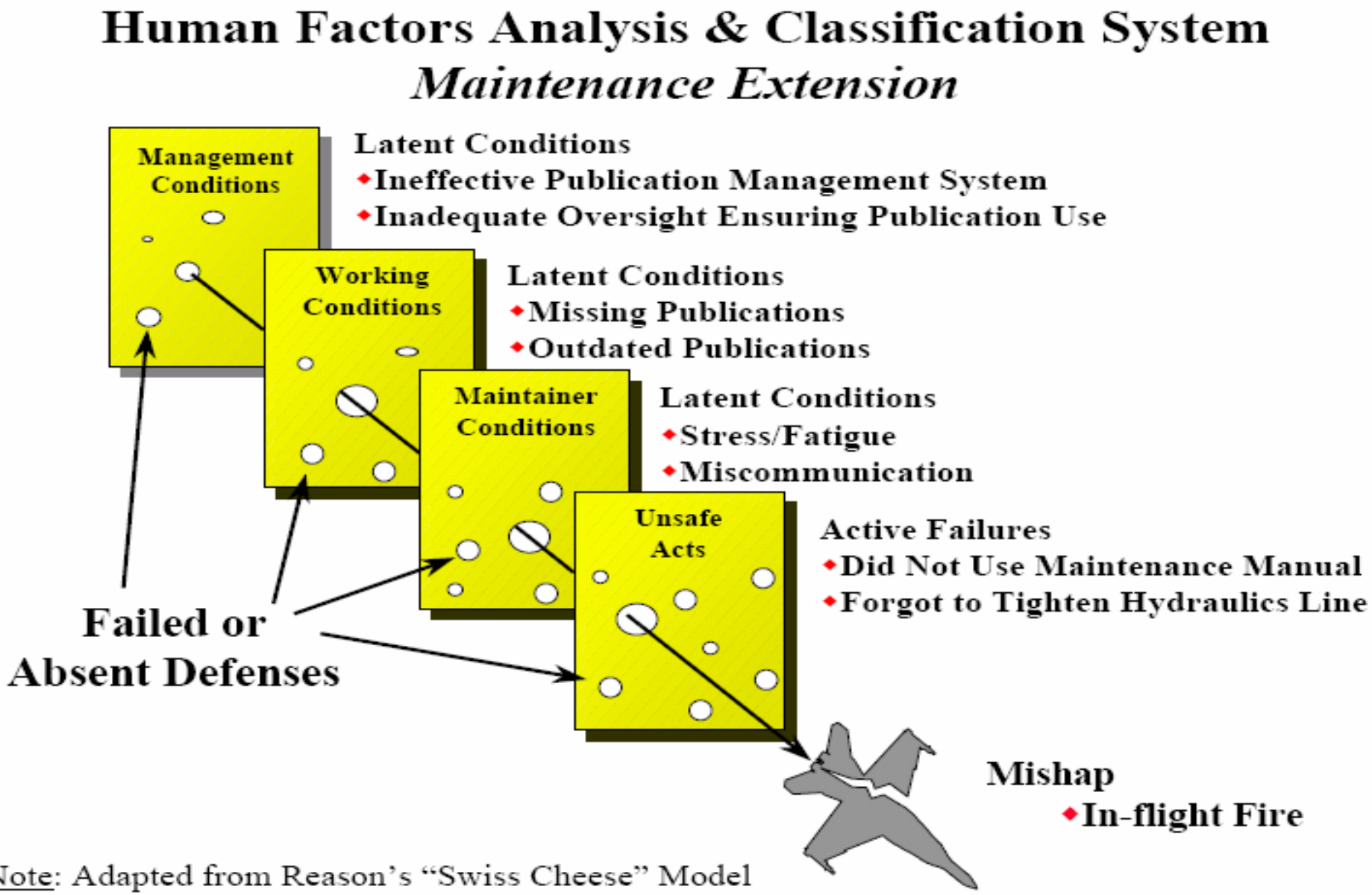


HUMAN FACTOR IN AVIATION SAFETY

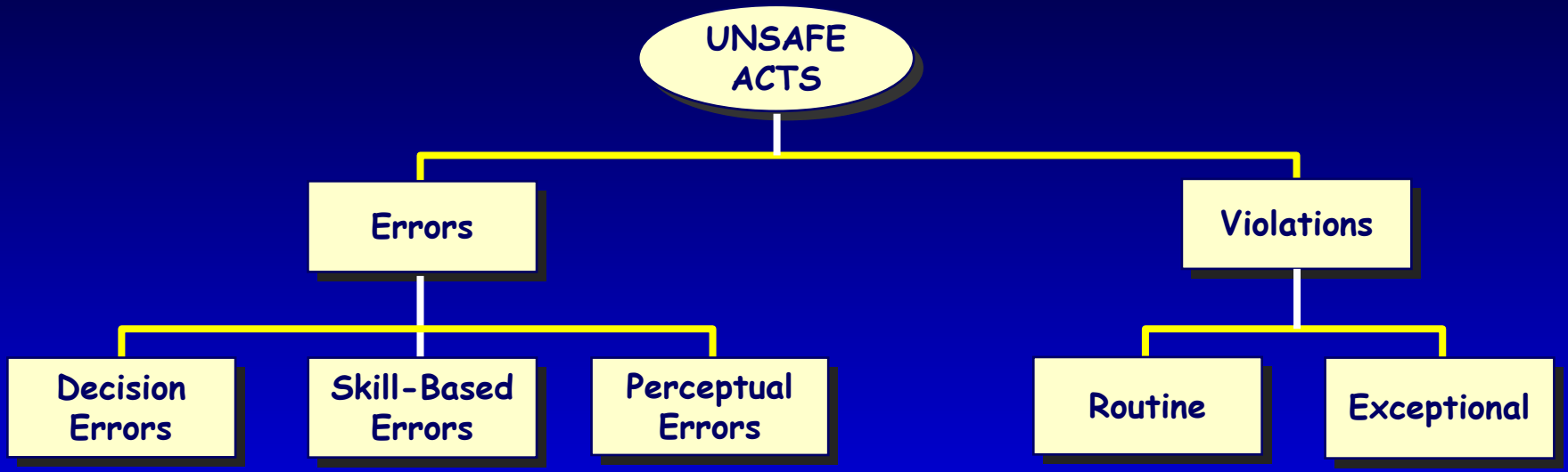
Human factors Analysis & Classification System (HFACS)



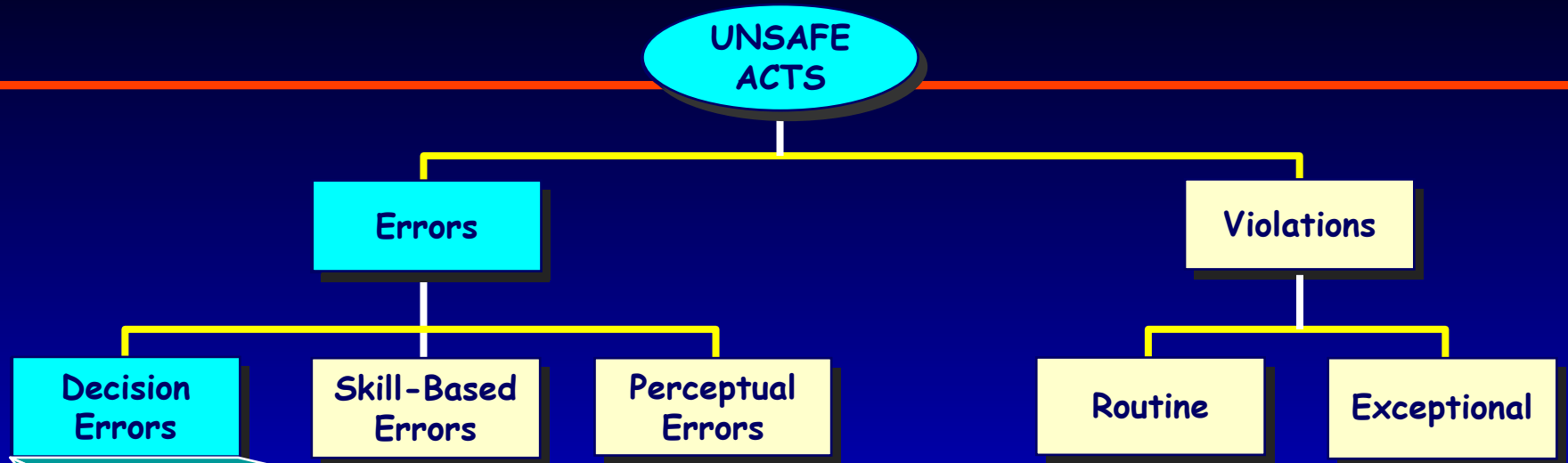
Application of HFAC in Maintenance



Human factors and safety



Human factors and safety



DECISION ERROR

- Rule-based Decisions
  - If X, then do Y
  - Highly Procedural
- Choice Decisions
  - Knowledge-based
- Ill-Structured Decisions
  - Problem solving

Human factors and safety

UNSAFE ACTS

- Errors
  - Decision Errors
  - Skill-Based Errors
  - Perceptual Errors
- Violations
  - Routine
  - Exceptional

SKILL-BASED ERRORS

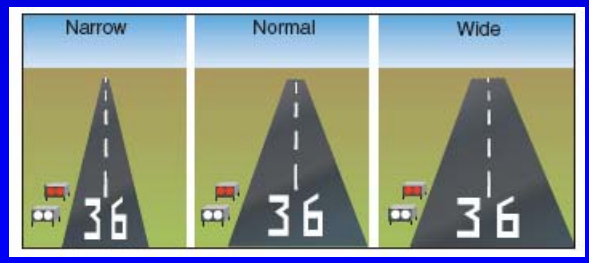
- Attention Failures
  - Breakdown in visual scan
  - Inadvertent operation of control
  - Failure to see and avoid
- Memory Failure
  - Omitted item in checklist
  - Omitted step in procedure

Human factors and safety

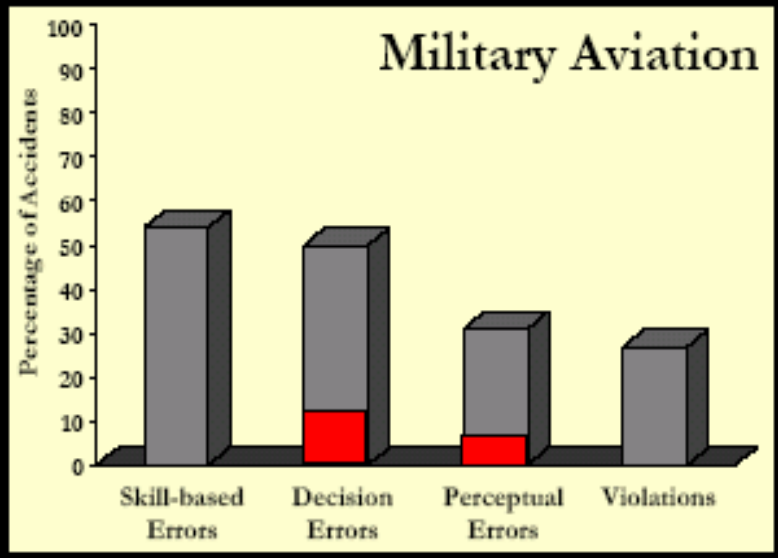
- UNSAFE ACTS
  - Errors
    - Decision Errors
    - Skill-Based Errors
    - Perceptual Errors
  - Violations
    - Routine
    - Exceptional

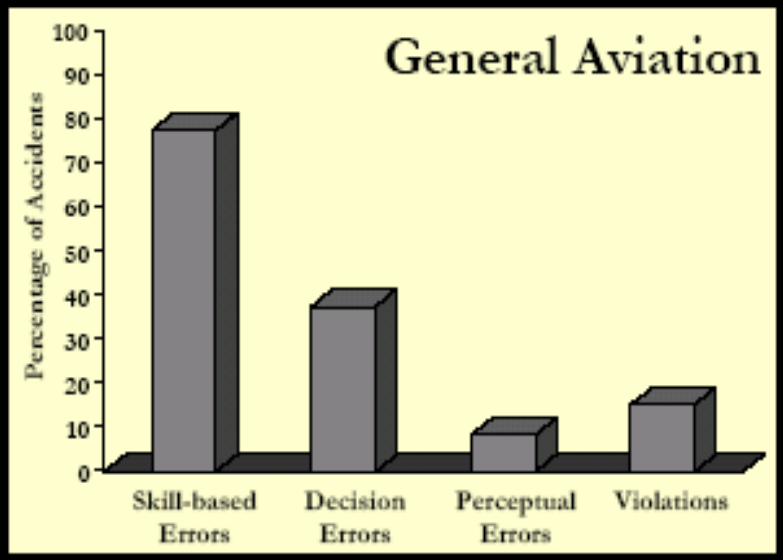
PERCEPTUAL ERRORS

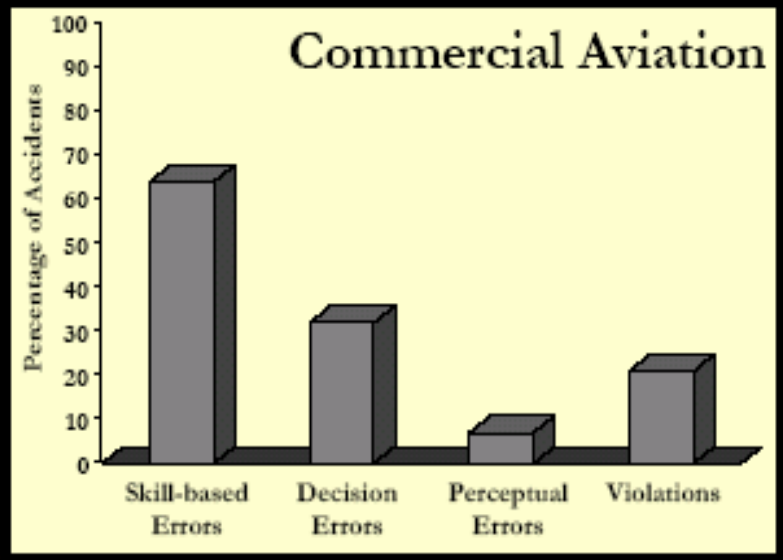
- Misjudge Distance, Altitude, Airspeed
- Spatial Disorientation
- Visual Illusions



Comparison of errors and violations







Reducing human errors

IT IS IMPOSSIBLE TO PREVENT ALL HUMAN ERRORS. HOWEVER, THE NUMBER AND SEVERITY CAN OFTEN BE REDUCED.

1. **Minimizing error in employee selection**
2. **Controlling of operating environment**
3. **Compensation for human error**
4. **Use of monitoring/alerting systems**

AIRCRAFT ACCIDENT INVESTIGATION

Purpose of Accident & Incident Investigation

- **Determine the cause or causes of the accident & incident,**
- **Identify any unsafe conditions, acts or procedures which contributed in any manner to the accident or incident .**
- **Recommend corrective action to prevent similar accidents & incidents.**
- **Reduce costs and down time**

Aircraft accident investigation stages

- **Identification & notification**
- **Investigation**
- **Analysis**
- **Reporting**

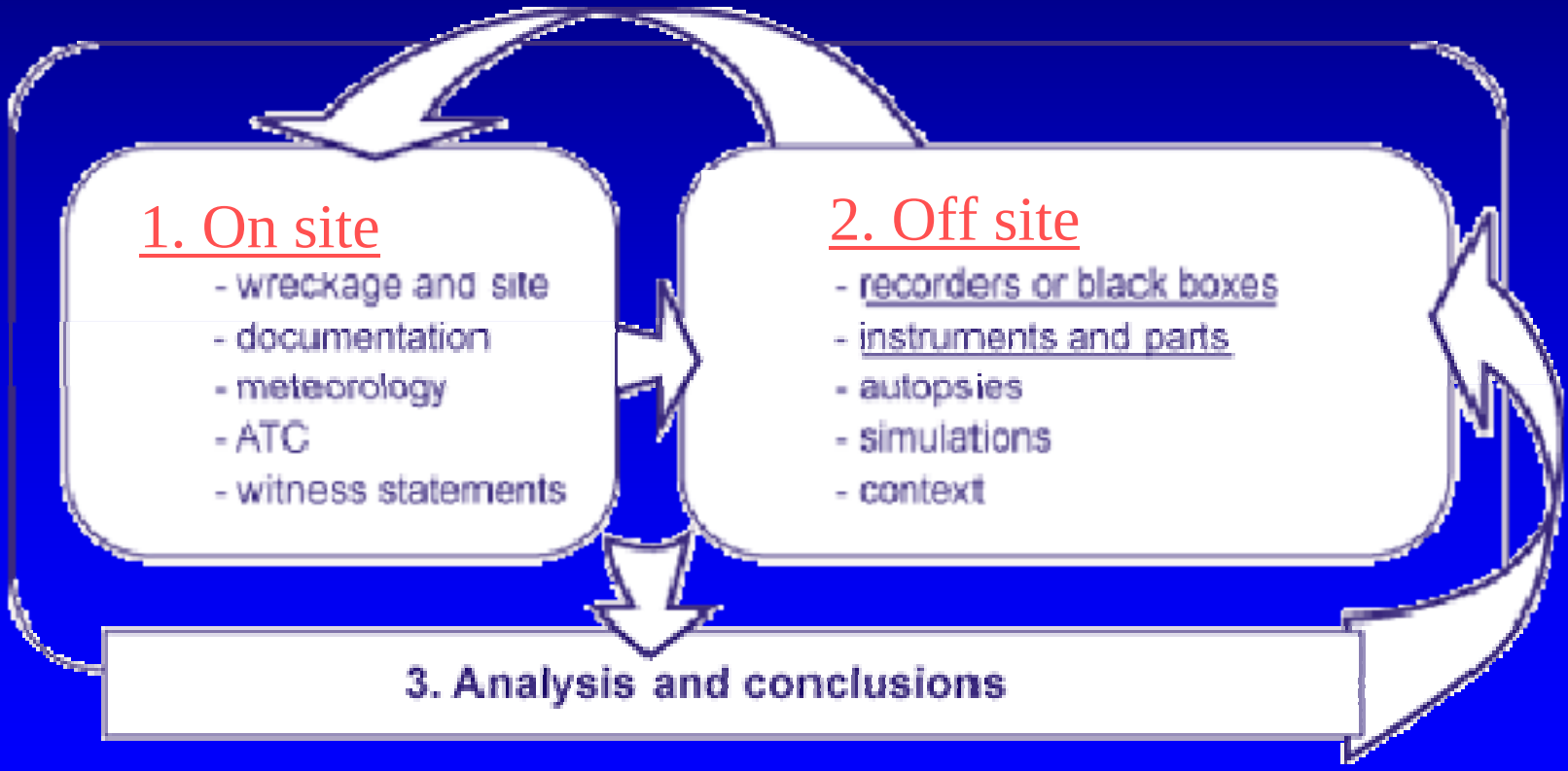
Phase I: Identification and Notification

- **Identification and notification phase involves identification of aircraft involved in accidents and notification of respective authorities**
- **An investigation team is formed and dispatched to the area.**
  - **An aviation safety officer.**
  - **An aviation maintenance officer.**
  - **An aircraft operations officer.**
  - **A flight surgeon**

- **The first two days following an accident are critical because the evidence is fresh and undisturbed. After people start going through the wreckage, the clues begin to disappear. An airspeed indicator's needle might be moved, or a fuel line might drain.**

Phase 2:Investigation stage

- **On site investigation phase**
- **Off site investigation phase**

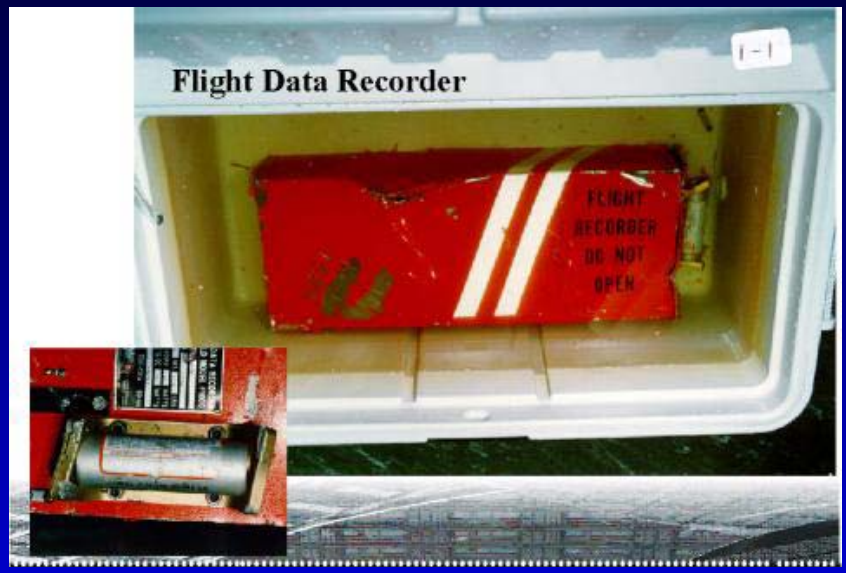


On-site investigation

- Site safety
- Walk through
- Wreckage distribution diagram
- Photography
- Component identification

Off site investigation

Investigation of Recorders & black box



Metallurgical Investigation

UH-1N Turbine: Helical shaft failure

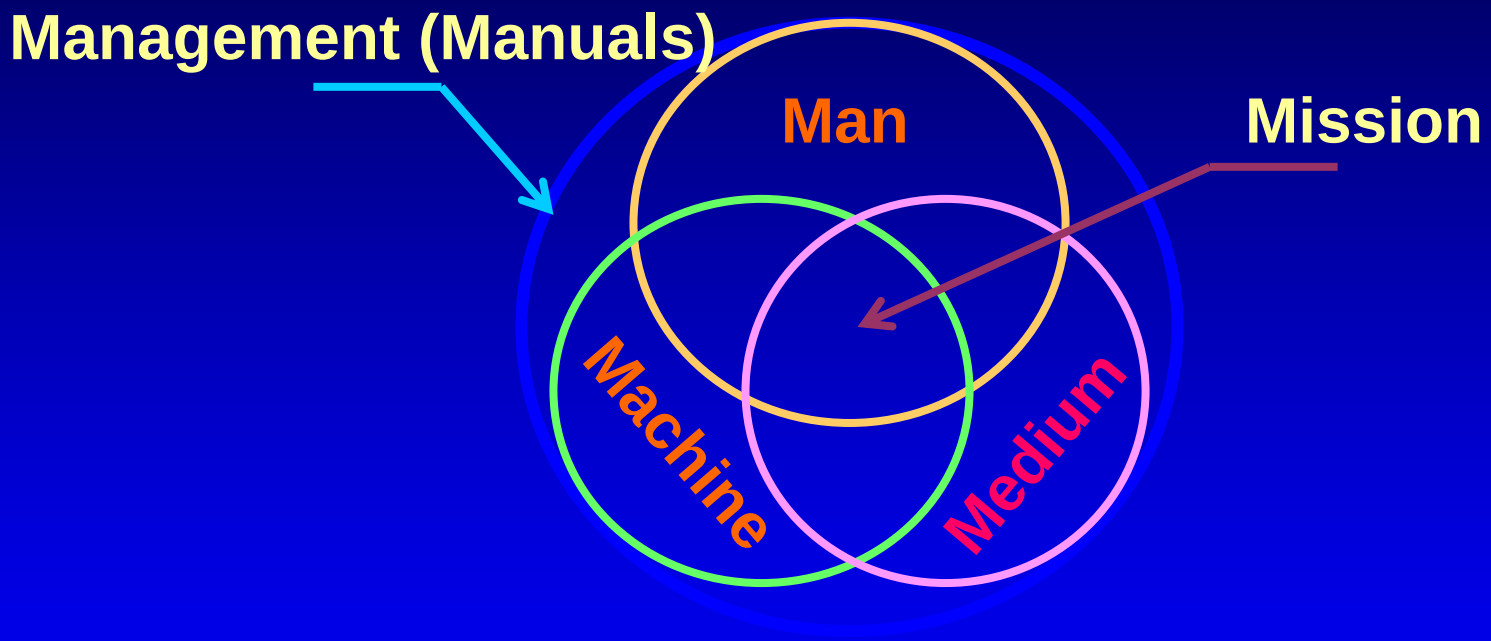
F-18 Engine Shaft Torsional Buckling

Torsion Failures
(ductile material behavior)

Phase 3: Analysis

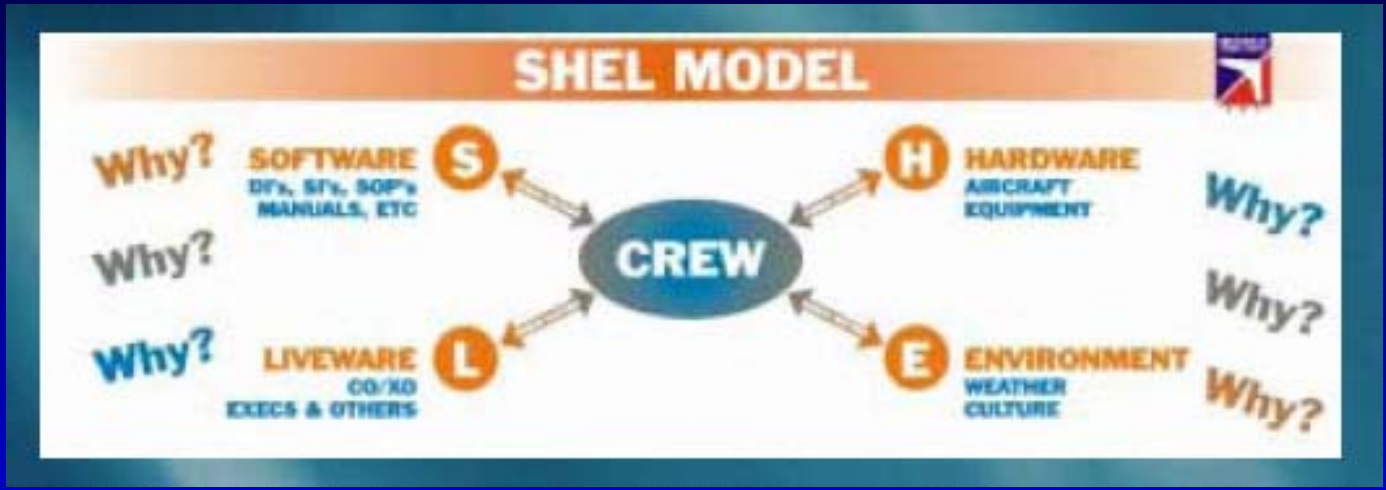
- **5-M MODEL**
- **SHEL(L) MODEL**
- **ACCIDENT RECONSTRUCTION**

The 5-M MODEL used in accident investigation



When seeking the causal factors of an accident, the analysis of the 5-M components ensures the consideration of all possible factors.

SHEL (L) MODEL



S- Software	**Manuals, procedures**
H- Hardware	**Aircraft, tools, equipments**
E-Environment	**Weather, noise, organization**
L-Liveware (others)	**Teamwork, leadership**
(L)-Liveware (crew)	**Knowledge, attitude, health**

Aircraft Accident Investigation

Most accidents have at four or five root causes or factors that contribute. Often there are more.
Your task is to identify as many as possible
Remember….

Focus on the system and not the individual

Focus on cause and not blame

Accident reconstruction

- **Aircraft accident reconstruction is a process of recreating (and quantifying) the motion of an aircraft during the three phases of the crash sequence.**
- **These phases of crash sequence are:**

- The pre-impact phase (or the initial-strike/attitude-change phase);

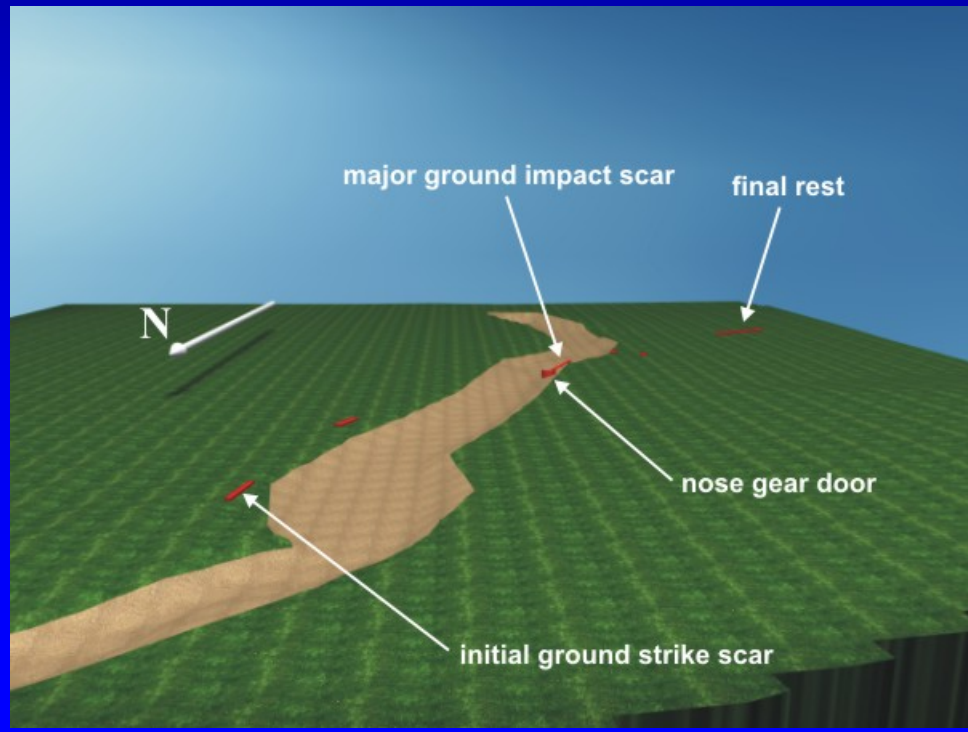
- The major impact phase (or the major-force/occupant-injury phase)

- The post-impact phase (or the bounce-slide/final-rest phase)

Accident Reconstruction

Physical evidences are used to determine impact phases.

Photo of accident site –looking south



CAD of accident site –looking south

Peak values of forward & lateral decelerations :

a_f = -10.2 g

a_l = -32.2 g (to the right)

Phase 4 :Reporting

- **With the completion of the fact-finding phase, the accident investigation process enters its final stage.**
- **The *final accident report* includes**
  - **A list of factual findings concerning the accident.**
  - **Analysis of those findings.**
  - **A probable cause statement.**
  - **Recommendations to prevent a repetition of the accident.**

Case Study : United Airlines 232

- **Date of Accident:19 July 1989**
- **Airline: *United Airlines***
- **Aircraft: McDonnell Douglas DC-10-10**
- **Location:Sioux City, Iowa, USA**
- **Flight Number:232**
- **Fatalities:112:298**
- **Engine Manufacturer: General Electric Engine**
- **Model:CF6-6D**
- **Year of Delivery:1973**

Case Study : United Airlines 232

Case Study : United Airlines 232

- **Metallurgical examination showed that the primary fracture had resulted from a fatigued section on the inside diameter of the engine fan disk. Further examination showed that the fatiguing had resulted in a small cavity on the surface of the disk, apparently a defect in manufacturing.**
- **The 17 year old disk had undergone routine maintenance and six times had been subjected to flourescent penetration inspections.**
- **Investigators concluded that human error was responsible in improperly identifying the fatigued area before the accident.**
- **Subsequent simulator tests showed that other DC-10 crews were unable to repeat the effort of the crew of 232. Investigators concluded that, in its damaged condition, it was not possible to land the aircraft on a runway.**

Case Study : Air France 296Q

Date:	**26 JUN 1988**
Time:	**14:45**
Type:	**Airbus 320-111**
Operator:	**Air France**
Registration:	**F-GFKC**
Year built:	**1988**
Total airframe hrs:	**22 hours**
Cycles:	**18 cycles**
Engines:	**2 CFMI CFM56-5A1**
Crew:	**0 fatalities / 6 on board**
Passengers:	**3 fatalities / 130 on board**
Total:	**3 fatalities / 136 on board**
Airplane damage:	**Written off**
Location:	**France**
Phase:	**Initial Climb**
Nature:	**Demonstration**
Flight number:	**296Q**

Case Study : Air France 296Q

Case Study : Air France 296Q

- **PROBABLE CAUSES:**

The Commission believes that the accident resulted from the combination of the following conditions:

1) Very low flyover height, lower than surrounding obstacles;

2) Engine speed at flight idle;

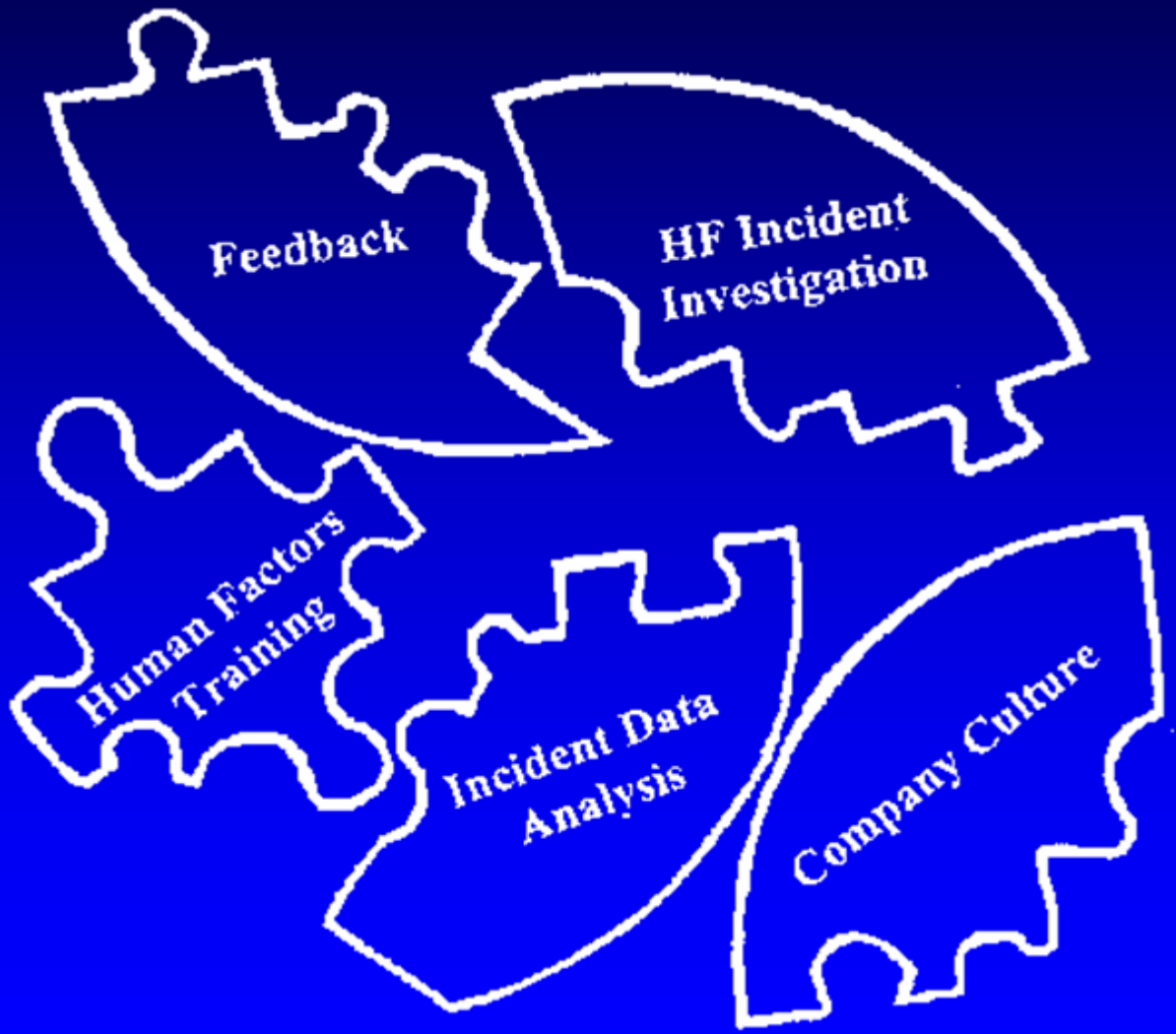
3) Late application of go-around power.

Case Study: Hard Landing

Conclusion

Conclusion

<u>CONCLUSION</u> :Accident prevention CANNOT be achieved focusing on a single element. It is like a puzzle.



CONCLUSION :To have a successful safety program, all program components must work effectively together.

"Whenever we talk about a crew who has been killed in a flying accident, we should all keep one thing in mind. He...made a judgment. He believed in it so strongly that he knowingly bet his life on it. But his judgment was faulty …

THANK YOU

Every instructor, supervisor, and friend who ever spoke to him had the opportunity to influence his judgement, so a little bit of all of us goes with every man we lose."
--Anonymous