•INVESTIGATION OF HUMAN FACTORS IN ACCIDENTS AND INCIDENTS

ICAO addressed the systematic investigation of human factors in aviation accidents and incidents in the 1993 circular *Human Factors Digest.* The main ideas highlighted in the circular concern contemporary approaches to the investigation of human factors in accidents and incidents including the application of the SHELL model and Reason's. Accident Causation Model to the collection, analysis and presentation of human factors information. The application of these models suggest that human error is viewed as a symptom or effect of air transportation system issues as opposed to narrowly regarding operator error as the final cause of accidents. Although the publication itself is relatively old, the ideas it describes are generic enough to remain relevant to present-day investigations and serve as an introduction to the investigation of human factors in aviation accidents and incidents. The information that follows is a synopsis of the contents of that ICAO circular.

The **Accident *Causation model* (or "Swiss Cheese Model")** is a theoretical model that illustrates how accidents occur in organizations. The model focuses on both organizational hierarchy and human error. It postulates that the typical accident occurs because several (human) errors have occurred at all levels in the organizational hierarchy in a way that made such accident unavoidable. For example, decision makers may have made ill decisions when purchasing aircraft **(*fallible decisions*)**, line management may have pushed for faster turnarounds, inadequate training ***(line management deficiencies)***, pilots may have felt pressurized to cope with a stressful climate, an unsafe culture and little rest **(preconditions),** the particular pilot who suffered the accident may have gotten distracted with other tasks three seconds prior to the accident ***(unsafe act),*** and the aircraft systems fail in providing unmistakable warnings of the danger ***(inadequate defenses).***

Above example illustrates key concepts in the Accident Causation Model:

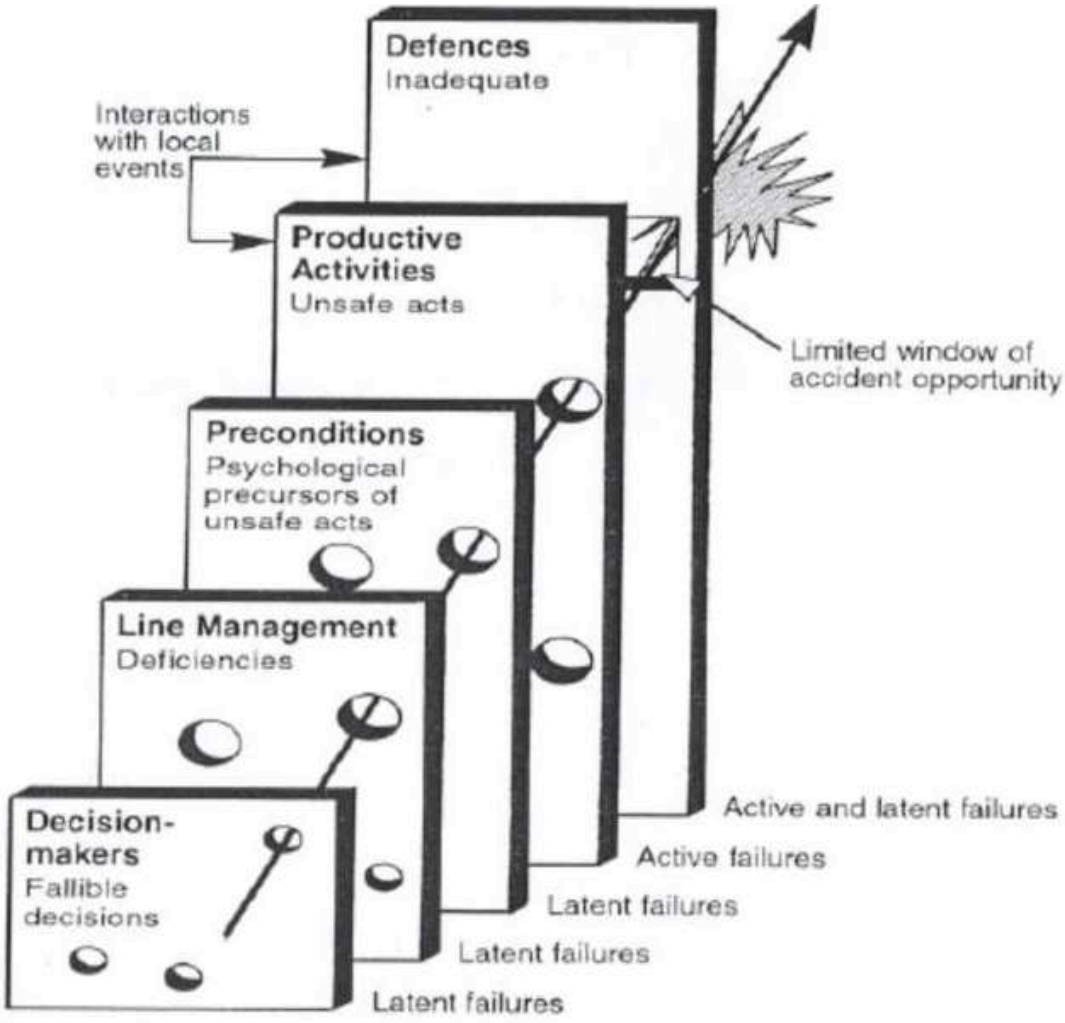
- **Active errors** (also called unsafe acts) are the proximal causes of the accident: the pilot got distracted. Hadn't the pilot got distracted, he would have prevented the accident.

- **Latent errors** are the remaining elements in the organization, which contributed to the accident: senior managers decisions, line management pressures, unsafe climate and culture coupled with fatigue and confusing warnings. Hadn't any of these latent errors occurred, the accident would have been prevented.

- **Windows of opportunity** refer to the opportunity for those active and latent errors to contribute to an accident. Hadn't the worker got distracted, he would have prevented the accident... this time. Yet, the latent errors remain unresolved, waiting for their opportunity (thus a "window of opportunity") to strike.

- **Causation chain** refers to the alignment of all necessary windows of opportunity at all levels in the organization, thus leading to the occurrence of a particular accident. That is, the causes of most accidents can be traced back to "windows of opportunity" opened at all levels in the organization.

The Accident Causation Model was first published by Reason in 1990. Since then, it has progressively influenced contemporary views on the management of human error in organizations. For instance, the International Civil Aviation Organization (ICAO) has formally adopted Reason's model to facilitate a systemic understanding of human factors issues within the aviation community



The Reasons Model (Swiss Cheese Model)

By identifying the involvement of human factors in accidents and incidents, new and better measures can be implemented to reduce the frequency and minimize the consequences of repetitive human errors. The events that led up to an accident or incident are the primary focus of the digest. Thus, the digest is relevant to investigators and investigation authorities, civil aviation regulatory authorities, corporate management and other aviation personnel with an interest in the subject area.

Need for, and purpose of, HF investigation

Human factors have, for many years, been recognized as a major contributing element in aviation incidents and accidents. Despite this knowledge, progress in adopting a uniform approach to the investigation of human factors has been slow. In some instances, the difficulty in dealing with the less tangible human factors issues has resulted in causes being

attributed to “pilot factors” in the absence of any tangible technical causes.

Accident investigation reports are usually effective in describing **what** happened and **when** but in many cases the reports **do not** explain **how** and **why** breakdowns in human performance occurred. This narrow focus tends to ignore the root causes of the human error, or performance deficiencies, making it difficult to determine, analyze or understand the underlying human factors issues with any degree of accuracy or consistency.

Human operators, often the final barrier that stops the sequence of events from causing an accident, are only one element of the complex aviation system. Therefore, when events line up to cause an aircraft accident or incident, the investigating authority must investigate all elements of the system to fully understand how and why the occurrence happened and identify underlying deficiencies that might potentially cause another occurrence. In other words, the investigating authority must adopt a systems approach to investigating human factors in accidents and incidents that examines the interactions between various aviation system components and how these components integrated to result in an accident/incident.

One such approach is provided by Reason's Accident Causation Model (or "Swiss Cheese Model").

This systems approach to human factors investigation encourages the investigator to go **beyond** the unsafe actions of front-line operators and **identify latent failures present in the system that are capable of contributing to future occurrences.** Identifying these latent failures within the aviation system, whether they are at an organizational or regulatory level, allows the investigator to achieve the purpose of human factors investigation - to identify why the front-line operator committed unsafe act(s) and how operator actions led to failure in defenses to determine the most effective corrective or preventive measures.

Conduct of the investigation

An effective and efficient human factors investigation is methodical and complete; it should be well integrated and coordinated with other investigation elements and requires appropriate management of all available resources. Planning and prioritizing the various elements of the investigation are extremely important. For instance, the investigator must assign high priority to the preservation and collection of evidence, especially information that is liable to being forgotten or disturbed, disappearing or becoming unavailable. This will ensure that human factors information will be available for analysis. Within an investigation team, the

human factors investigator or group must cooperate and interact with other team members who will also collect data on relevant human factors aspects during the course of their work. In the case of a major aircraft accident, the human factors group is generally responsible for coordinating human factor elements, this includes ensuring appropriate and sufficient data are collected as well as producing meaningful results. Investigators must collect information on the decisions, actions and **behaviors** of all people involved in the occurrence and the **conditions under which these dimensions were carried out** to obtain a full understanding of how the window of accident opportunity was created. This information can be acquired from both primary and secondary sources. Primary sources reveal factual field information. Secondary sources provide additional empirical information about human factors that may be used to facilitate analysis of primary information.

The **SHELL model** facilitates data collection by providing a systematic approach to identifying human factors issues.

Information collected during the human factors investigation should allow a thorough analysis of each SHELL component and identify where mismatches, or interactions, between these components and the central human operator contributed to the occurrence.

Data collected on the human operator (liveware component) at the centre of the SHELL model can be broken down into physical, physiological, psychological and psychosocial considerations. In determining how much information is enough, good judgment is required by the investigator.

Part of this judgment requires some form of ongoing analytical reasoning process to integrate and develop various aspects of the investigation.

However, the depth and detail of information collected during the human factors investigation is limited by available investigative resources and should exclude aspects pursued for a purpose unrelated to accident prevention**. For instance, data concerning who to blame is irrelevant to the purpose of investigating human factors and should not be collected as it fails to help explain how and why the causal event sequence was initiated and not stopped before the accident/incident occurrence**.

Further problems that investigators must consider when analyzing human factors information include

1. Assessment of relevance of abnormal/non-standard behavior.

2. Sensitivity and privacy considerations and

3. Speculation avoidance

Reporting and preventive action

Varied readership and sensitivity to different reader motivations are important factors to consider when writing the investigation report. However**, the most important readers are the decision-makers responsible for implementation of the report's safety recommendations**. These decision-makers must be convinced by the report if preventive actions are to be taken. As a result, the report must state accident/incident causes, identify hazards uncovered during the investigation, indicate effective or ineffective handling of the hazards and offer recommendations to **eliminate or CONTROL HAZARDS so as to PREVENT FUTURE ACCIDENTS.**

Decision-makers are not going to act on a flawed or poorly substantiated report therefore for the sake of accident prevention, it is important that the report is complete and accurate. The final report must be structured in an orderly and logical manner, guided by the standard format, consisting of various sections contained in the appendix to ICAO *Annex 13*. Section 1 of the report concerns factual information that describes what happened as well as information pertinent to understanding the conditions and circumstances of the occurrence.

Section 1 and its subsections contain human factors information and issues, including history of flight, personnel information, aircraft information, additional information etc. Throughout this section, deviations, discrepancies and hazards are compared to a recognized aviation standard/empirical evidence to provide the foundation for analysis of their influence on the accident sequence of events.

Section 2 of the report concerns the analysis, identifying the existence and notion of human factors involvement. It describes or validates the reasons why the circumstances resulted in the accident/incident thus creating a link between the factual information provided in Section 1 and the conclusions provided in Section 3. Discussion of the causation chain, causal hazards and non-contributory hazards that warrant safety action is a key part of the analysis section. The analysis section may be logically sequenced in any number of ways according to the particular circumstances of the accident/incident. For instance, each sub-section may read like a mini accident report, developing the relationship between causal links.

Similarly, Reason's accident causation model may be used as a systematic

framework to present the analysis of factual information.

Section 3 of the report concerns the conclusions. Conclusions should identify all hazards that need to be addressed, cause-related or not. Conclusions about causes should consist of concise statements regarding the reasons why the accident happened.

Causal statements should be

1. Listed with all causes considered,

2. Formulated with consideration to corrective and preventive measures,

3. Linked to safety recommendations and

4. Written without hints of blame or liability.

Section 4 of the report concerns safety recommendations for preventive action and should address all identified hazards that need to be rectified, both matters directly associated with the causal factors of the occurrence and non-causal matters revealed by the investigation process.

Various alternative safety recommendations should be assessed for technical feasibility, acceptability, practicality, ease of implementation and appropriateness for the recipient of the recommendations. Furthermore, in accordance with Reason's model, safety recommendations for preventive measures should focus on **underlying system hazards created or ignored by management. These preconditions for unsafe acts are often the result of management decisions, action or inaction**.

Safety recommendations should be general rather than authoritative.

Thus, recommendations should not focus on how to make changes but rather what needs to change to

1. Eliminate safety hazards (first and foremost),

2. Modify the system to reduce hazard risk or

3. Teach people how to cope with hazards that cannot be controlled.

Conversely, effective identification, elimination or mitigation of safety hazards is dependent on the response strategies that aviation companies, manufacturers or regulators adopt.

Response strategies include

1. Problem denial,

2. Repairing the problem to prevent recurrence or

3. System reform/optimization.

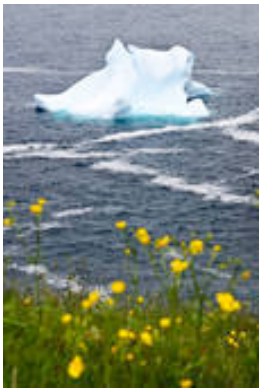
After the draft final report is produced, it is circulated to the States involved in an accident investigation for consultation and review. This consultative process could also occur within a State between parties involved in a domestic occurrence.

Finally, human factors data collected during an accident/incident investigation should be recorded in a database to facilitate future safety analysis, In order to learn from the lessons of others there is a need to provide improved means of reporting and recording human factors data in a user-friendly manner.

Summary

When a Hull Loss happens, do not stop at Pilot Error (tip of an iceberg).

What is quite obvious – As seen, the easy way out!



Well a true investigation actually begins with

PILOT ERROR!

The above shown pictures are just dots. There are more lessons to be learned, to avoid any future occurrences.

Latent or Hidden Threats

"Accident investigation reports are usually effective in describing **what** happened and **when** but in many cases the reports do not explain **how** and **why** breakdowns in human performance occurred. This narrow focus tends to ignore the root causes of the human error, or performance deficiencies, making it difficult to determine, analyze or understand the underlying human factors issues with any degree of accuracy or consistency"

CHECK QUESTION

ARE WE INVESTIGATING THE DRYDEN WAY?

ICAO ANNEX 13

*"The fundamental objective of investigation of an accident or incident shall be the **prevention** of accident or incident"*

*"It is **not** the purpose of this activity to apportion blame or Liability"*

M.Manhas. (Air India Ltd)