MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
NATIONAL AVIATION UNIVERSITY
FACULTY OF AIR NAVIGATION, ELECTRONICS AND TELECOMMUNICATIONS
DEPARTMENT OF AVIONICS

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'___'___________2024

QUALIFICATION PAPER

(EXPLANATORY NOTES)

FOR THE DEGREE OF «BACHELOR»

SPECIALITY 173 'AVIONICS'

Theme: 'The Impact of Human Factors on Aviation Incidents Involving Controlled Flight into Terrain'

Done by: ____AV356.Ба/стн_Golub Leonid Yuriyovich__
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Kyiv 2024

МІНІСТЕРСТВО ОСВІТИ І АУКИ УКРАЇНИ
НАЦІОНАЛЬНИЙ АВІАЦІЙНИЙ УНІВЕРСИТЕТ
ФАКУЛЬТЕТ АЕРОНАВІГАЦІЇ, ЕЛЕКТРОНІКИ ТА ТЕЛЕКОМУНІКАЦІЙ
КАФЕДРА АВІОНІКИ

ДОПУСТИТИ ДО ЗАХИСТУ
Завідувач кафедри
_________Ю.В. Грищенко
«___» ___________2024

КВАЛІФІКАЦІЙНА РОБОТА

(ПОЯСНЮВАЛЬНА ЗАПИСКА)

ВИПУСКНИКА ОСВІТНЬОГО СТУПЕНЯ «БАКАЛАВР»
ЗА СПЕЦІАЛЬНІСТЮ 173 «АВІОНІКА»

Тема: «Вплив людського фактору на авіаційні події при зіткненні з землею в керованому польоті»

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Київ 2024

NATIONAL AVIATION UNIVERSITY

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Specialty 173 ‘Avionics’

APPROVED

Head of the department
__________ Yu.V.Hryshchenko
‘___’____________2024

TASK

for qualification paper

Golub Leonid Yuriyovich

1. Theme: ‘The Impact of Human Factors on Aviation Incidents Involving Controlled Flight into Terrain’ approved by order 385/ст of the Rector of the National Aviation University of 14 March 2024.

2. Duration of which is from 13 May 2024 to 16 June 2024.

3. Input data of graduation work:

4. Content of explanatory notes: List of conditional terms and abbreviations, Introduction, Chapter 1, Chapter 2, Chapter 3, References, Conclusions.

5. The list of mandatory graphic materials: Figures, charts, and graphs.

6. Planned schedule

№	Task	Duration	Signature of supervisor
1.	Validate the rationale of the qualification paper theme	13.05.2024	
2.	Carry out a literature review	15.05.2024	
3.	Develop the first chapter of the qualification paper	22.05.2024	
4.	Develop the second chapter of the qualification paper	29.05.2024	
5.	Develop the third chapter of the qualification paper	05.06.2024	
6.	Tested for anti-plagiarism and obtained a review of the qualification paper	03.06.2024	
7.	Preparation of presentation and report	16.06.2024	

8. Date of assignment: ‘___ ‘ ____________ 2024

Supervisor ______________

The task took to perform ______________

(Signature) (surname, name, patronymic)

ABSTRACT

Explanatory notes to qualification paper The Impact of Human Factors on Aviation Incidents Involving Controlled Flight into Terrain' contained 71 pages, 6 figures, 2 table, and 11 references.

Keywords: HUMAN FACTORS, AVIATION SAFETY, CONTROLLED FLIGHT INTO TERRAIN (CFIT), PILOT ERROR, SITUATIONAL AWARENESS, DECISION MAKING, AVIATION INCIDENTS, RISK MANAGEMENT, FLIGHT SAFETY.

The Object of the Research - The process of analyzing the impact of human factors on aviation incidents involving controlled flight into terrain (CFIT).

The Subject of the Research - Human factors contributing to aviation incidents of controlled flight into terrain (CFIT).

Purpose of Graduation Work - Investigation of how human factors influence aviation incidents, specifically those involving controlled flight into terrain, and the development of strategies to mitigate these risks.

Research Method - Methods of decision theory, human factors analysis, probability theory, statistics, information theory, and expert judgment method were employed to address the role of human factors in CFIT incidents.

Scientific Novelty - Proposed recommendations and strategies for reducing the incidence of controlled flight into terrain (CFIT) through improved understanding and management of human factors in aviation.

CONTENTS

LIST OF ABBREVIATIONS

1. CFIT - Controlled Flight Into Terrain
2. MSA - Minimum Safe Altitude
3. VMC - Visual Meteorological Conditions
4. ATCO - Air Traffic Control Officer
5. ILS - Instrument Landing System
6. LLZ - Localizer
7. HFACS - Human Factors Analysis and Classification System
8. STAMP - Systems Theoretic Accident Modelling and Processes
9. ICAO - International Civil Aviation Organization
10. TAWS - Terrain Avoidance Warning Systems
11. SOPs - Standard Operating Procedures
12. EGPWS - Enhanced Ground Proximity Warning System
13. LOCI - Loss of Control Inflight
14. USAF - United States Air Force
15. IATA - International Air Transport Association
16. ADM - Aeronautical Decision Making
17. PBN - Performance-Based Navigation
18. CRM - Crew Resource Management

INTRODUCTION

There is an old aviation story, which may indeed be apocryphal, that in the years of the expanding Army Air Forces prior to World War II, General Arnold, concerned about the high rate of aircraft accidents, appointed a committee to study the problem. As the story goes, in the interest of impartiality, he chose a cavalry officer to head the group. At the end of the study, the committee reported back that the primary cause of military aviation accidents was the aircraft striking the ground: Today the joke is somewhat dated, and it may not have been funny even when it was current

As air travel continues to grow in both scope and frequency, ensuring the safety of flight operations becomes paramount. This study is timely, addressing the urgent need to understand and mitigate human factors contributing to CFIT incidents, which remain among the most lethal types of aviation accidents.

Controlled Flight Into Terrain accidents are particularly tragic because they usually involve aircraft that are fully operational and under the control of highly trained flight crews. The fact that these incidents continue to occur despite the presence of advanced navigational aids and safety systems such as the Enhanced Ground Proximity Warning System (EGPWS) highlights a significant gap in the current aviation safety paradigm. It underscores the necessity to focus on the human element of cockpit operations—specifically, how pilots interact with these systems and make decisions under pressure.

The actuality of investigating human factors in CFIT incidents is underscored by several high-profile accidents in recent years, which have shown that technological solutions alone are insufficient to eliminate such tragedies. This research is essential for advancing our understanding of the cognitive, psychological, and situational variables that influence pilot behavior and decision-making processes. By identifying and analyzing these factors, the study aims to contribute to the development of more effective training programs, improved cockpit design, and better regulatory practices that can significantly reduce the likelihood of CFIT incidents.

Moreover, the study's relevance is magnified by the ongoing changes in the aviation industry, including the introduction of new technologies and the increasing complexity of cockpit environments. These changes can potentially introduce new types of human errors.

There is a pressing need for updated research that can keep pace with these developments, ensuring that safety training and regulations are based on the most current data and effective practices.

In addition to enhancing safety, understanding the human factors in CFIT incidents also has significant implications for economic and regulatory aspects of aviation. CFIT accidents result in severe financial consequences for airlines, including loss of life, loss of aircraft, and subsequent legal liabilities. Improving pilot training and cockpit design to address human factors effectively can lead to substantial cost savings and reduce the economic impact of these accidents on the aviation industry.

In aviation a controlled flight into terrain CFIT is an accident in which an airworthy aircraft, fully under pilot control, is unintentionally flown into the ground, a mountain, a body of water or an obstacle. In a typical CFIT scenario, the crew is unaware of the impending collision until impact, or it is too late to avert. The term was coined by engineers at Boeing in the late 1970s.

Accidents where the aircraft is out of control at the time of impact, because of mechanical failure or pilot error, are classified instead as uncontrolled flight into terrain, or UFIT. Incidents resulting from the deliberate action of the person at the controls, such as a forced landing, an act of terrorism, or suicide by pilot, are also excluded from the definition of CFIT.

According to Boeing in 1997, CFIT was a leading cause of airplane accidents involving the loss of life, causing over 9,000 deaths since the beginning of the commercial jet aircraft. CFIT was identified as a cause of 25% of USAF Class A mishaps between 1993 and 2002. According to data collected by the International Air Transport Association (IATA) between 2008 and 2017, CFITs accounted for six percent of all commercial aircraft accidents, and was categorized as "the second-highest fatal accident category after Loss of Control Inflight (LOCI)."

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CHAPTER 1
INTRODUCTION TO THE TOPIC OF CONTROLLED FLIGHT INTO TERRAIN (CFIT)

1.1 Introduce the topic of Controlled Flight into Terrain (CFIT) incidents and their significance in aviation safety

Controlled Flight into Terrain (CFIT) occurs when an airworthy aircraft under the complete control of the pilot is inadvertently flown into terrain, water, or an obstacle. The pilots are generally unaware of the danger until it is too late.

With official concern growing. a new term was born in 1974: "controlled flight into terrain." The accidents were not new, only the terminology. A strict definition is not possible, but the notion behind the term is an aircraft, in normal flight regime, with no emergencies and no warning to the crew of any impending trouble. impacting the terrain (or water) at some place other than the runway.

Most CFIT accidents occur in the approach and landing phase of flight and are often associated with non-precision approaches.

Many CFIT accidents occur because of loss of situational awareness, particularly in the vertical plane, and many crash sites are on the centreline of an approach to an airfield. Lack of familiarity with the approach or misreading of the approach plate are common causal factors, particularly where the approach features steps down in altitude from the initial approach fix to the final approach fix.

Effects Collision with the ground resulting in Hull Loss and fatalities/injuries.

Defences

Standard Operating Procedures (SOPs).

Terrain Avoidance Warning Systems (TAWS).

Situational awareness in relation to terrain

Typical Scenarios

Pilot-induced situation: The pilot encountered weather conditions that were worse than forecast and, in an attempt to maintain or regain visual contact with the ground in an area of very low cloud, descended below Minimum Safe Altitude (MSA) and the aircraft struck the ground. Contributing to this accident was the pilot's over-reliance on GPS while attempting to maintain Visual Meteorological Conditions (VMC) and a resultant lack of adequate situational awareness of terrain.

ATCO-induced situation: The controller gave an aircraft which was still at 210 KIAS an intermediate heading towards the ILS centreline during a radar vectored initial approach but was subsequently distracted and failed to issue the intercept heading for the ILS LLZ. When the flight crew, who were unfamiliar with the approach, failed to notice the situation in time to query it, the aircraft flew beyond the centreline and into high terrain on the other side before resolution was possible.

Contributory Factors

Weather: Rain, turbulence, and icing, may increase the workload of the pilot and cause interference reducing the accuracy of radio navigation beacons. Poor visibility, particularly at night can contribute to disorientation and loss of situational awareness.

Approach Design and documentation: The depiction of an approach, and particularly step-down fixes, on Terminal Approach Procedure (TAP) plates may not be clear. Approaches may take aircraft close to high terrain in order to comply with diplomatic or noise abatement constraints, or to deconflict with departure routes.

Failure to use Standard Phraseology leading to confusion and misunderstanding.

Pilot fatigue and disorientation. Approach and landing is a demanding phase of flight for pilots.

Accident Precursors

Study of CFIT accidents has enabled a large number of accident precursors to be identified. These precursors are not necessarily contributing factors, though some may be; but they are warnings revealing that a weakness has been detected in existing defence mechanisms. The identification of an accident precursor usually necessitates action to strengthen these defences.

The article CFIT Precursors and Defences lists those CFIT precursors which have so far been identified, together with suggested lines of defence.

1.1.1 Models used for CFIT

The study of human factors in aviation has been an important factor in the evolution of flight safety, in modern aviation. There has been an evolution of frameworks, most important of which are the Human Factors Analysis and Classification System (HFACS), the Systems Theoretic Accident Modelling and Processes (STAMP) model, Dupont Human Performance Model, Accimap, Pilot Competencies Model. The Systems Theoretic Accident Modelling and Processes (STAMP) model is a constraints-based model that uses control theory to describe the interaction between system components and the implemented controls used within a specific system (Leveson, 2004). In accident analysis, STAMP generates a description of a specific systems control structure where it then identifies failures within this structure that were factors in the accident (Leveson, 2012). The Dupont Human Performance Model, also known as Dupont's Dirty Dozen includes 12 defined human error elements that act as precursors to accidents. According to Dupont (1997) those are: (1) Lack of communication; (2) Lack of teamwork; (3) Lack of knowledge; (4) Lack of awareness; (5) Lack of assertiveness; (6) Lack of resources; (7) Fatigue; (8) Pressure; (9) Complacency; (10) Stress; (11) Distraction and (12) Norms. This model, having been created for aircraft maintenance, was subsequently adapted for use amongst all personnel in volved with aviation.

The Dupont model was also used by ICAO (1995) in their investigation of specific CFIT accidents in 2014. Accimap is used to graphically illustrate system failures, decisions and specific acts that are involved in an accident (Rasmussen, 1997). This approach differs from other accident analysis techniques by identifying causal factors from all parts of the system in which the accident took place. This ranges from the physical sequence of events and activities of the individuals involved, right up to the causes at the govern mental, regulatory, and societal levels. Unlike other methods for accident analysis, this approach also assembles the contributing factors into a coherent causal diagram that illustrates the interrelationships be-tween them, thereby highlighting the problem areas that should be addressed to prevent similar accidents from occurring in the future. This process is useful for highlighting the organizational and systemic inadequacies that contributed to the accident, so that attention is not directed solely towards the events and human errors that led direct to the accident. The Dupont model does not offer a comprehensive list of human error accident precursors. The model has been widely utilized across the aviation maintenance industry allowing future use in other sectors of aviation. While the model has deficiencies it could be developed or used in conjunction with another model when investigating aviation accidents. This is also the case with the "Pilot Competencies Model" where a comprehensive list of factors is lacking, however, it can be purpose fully utilized with another model. Both STAMP and Accimap can be viewed as cumbersome and time consuming when applied to complex aviation investigations. Leveson (2012) suggested that STAMP does not lend itself to a simple graphical representation of an accident. While HFACS is time consuming it was specifically designed for the investigation of aviation accidents and is more consistent due to its use of classifications and nanocodes (Salmon, Cornelissen and Trotter, 2011).

1.2 Human Factors Analysis and Classification System

The Human Factors Analysis and Classification System (HFACS) was developed by Dr Scott Shappell and Dr Doug Wiegmann. It is a broad human error framework that was originally used by the U.S. Navy to investigate and analyse human factors aspects of aviation. HFACS is heavily based upon James Reason's Swiss cheese model (Reason 1990) show by Fig. 1.1.

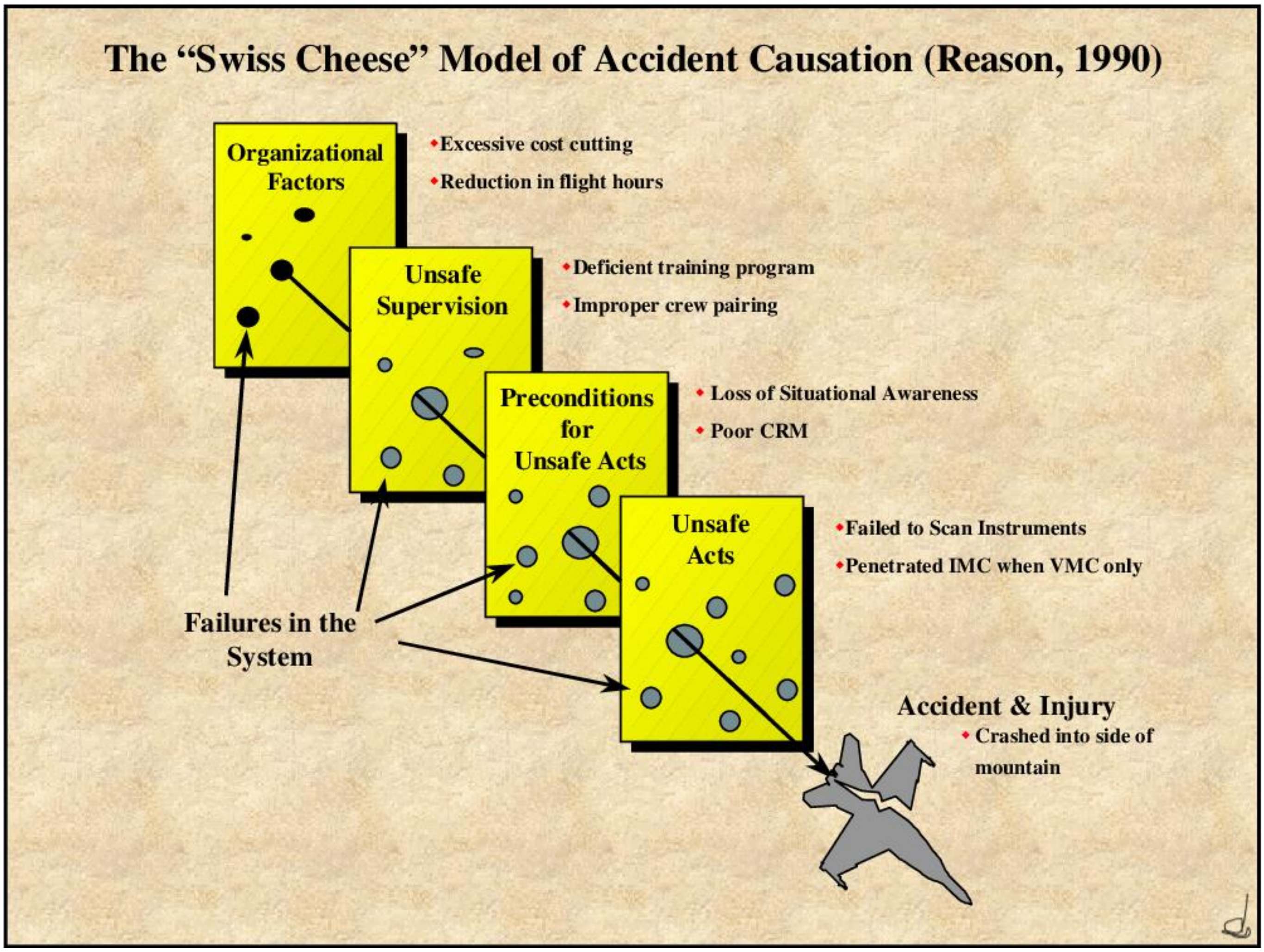

Fig. 1.1. The "Swiss cheese" model of accident causation (Reason 1990)

The HFACS framework provides a tool to assist in the investigation process and target training and prevention efforts. Investigators are able to systematically identify active and latent failures within an organisation that culminated in an accident. The goal of HFACS is not to attribute blame; it is to understand the underlying causal factors that lead to an accident.

The HFACS Framework

The HFACS framework (Figure 1.2.) describes human error at each of four levels of failure:

Unsafe acts of operators (e.g., aircrew), Preconditions for unsafe acts,

Unsafe supervision, and

Organisational influences.

Within each level of HFACS, causal categories were developed that identify the active and latent failures that occur. In theory, at least one failure will occur at each level leading to an adverse event. If at any time leading up to the adverse event, one of the failures is corrected, the adverse event will be prevented.

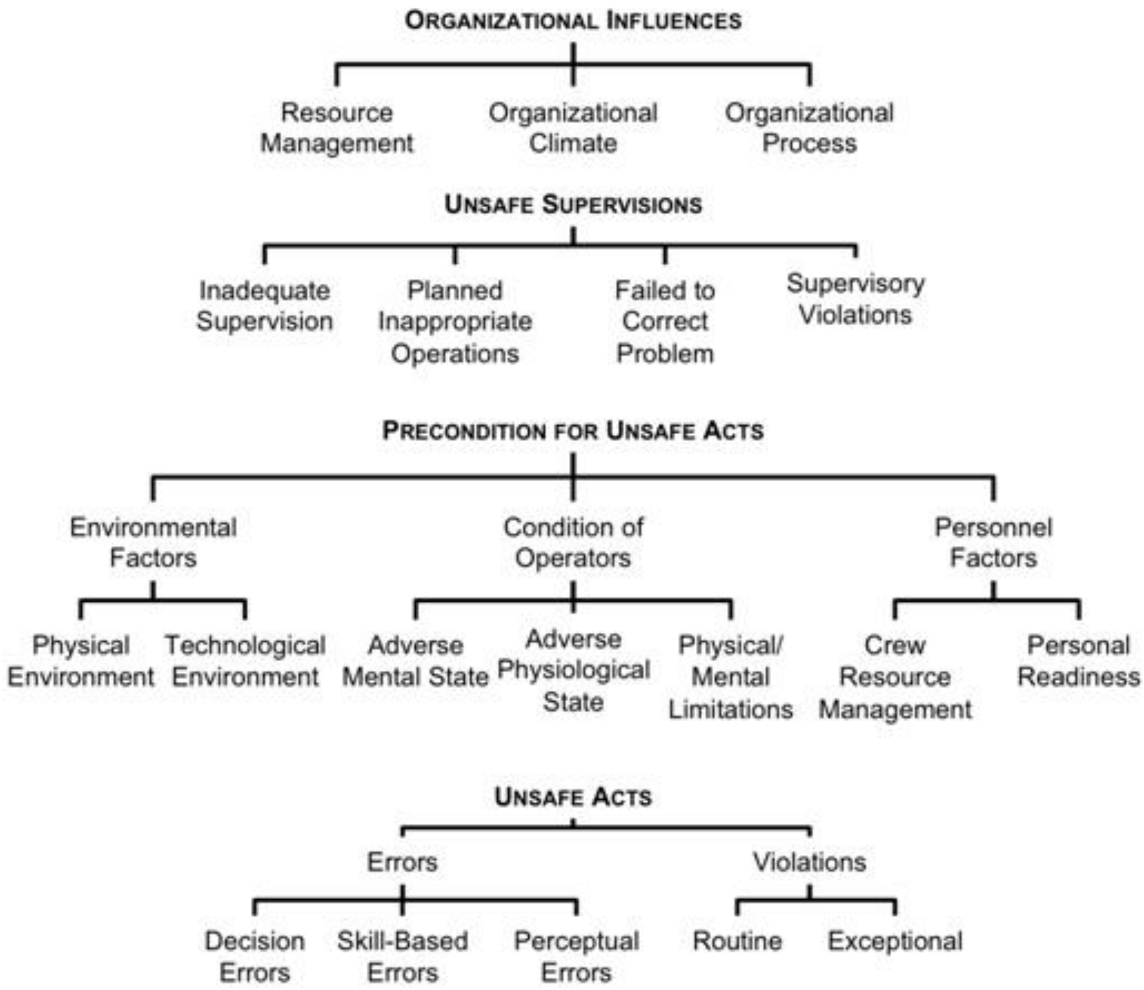

Fig. 1.2. The HFACS framework

HFACS Level 1: Unsafe Acts

The Unsafe Acts level is divided into two categories - errors and violations - and these two categories are then divided into subcategories. Errors are unintentional behaviors, while violations are a willful disregard of the rules and regulations.

Errors

Skill-Based Errors: Errors which occur in the operator's execution of a routine, highly practiced task relating to procedure, training or proficiency and result in an unsafe situation (e.g., fail to prioritise attention, checklist error, negative habit).

Decision Errors: Errors which occur when the behaviors or actions of the operators proceed as intended yet the chosen plan proves inadequate to achieve the desired end-state and results in an unsafe situation (e.g, exceeded ability, rule-based error, inappropriate procedure).

Perceptual Errors: Errors which occur when an operator's sensory input is degraded and a decision is made based upon faulty information.

Violations

Routine Violations: Violations which are a habitual action on the part of the operator and are tolerated by the governing authority.

Exceptional Violations: Violations which are an isolated departure from authority, neither typical of the individual nor condoned by management.

HFACS Level 2: Preconditions for Unsafe Acts

The Preconditions for Unsafe Acts level is divided into three categories:

- environmental factors,
- condition of operators, and
- personnel factors.

These three categories are further divided into subcategories. Environmental factors refer to the physical and technological factors that affect practices, conditions and actions of individual and which result in human error or an unsafe situation. Condition of operators refers to the adverse mental state, adverse physiological state, and physical/mental limitations factors that affect practices, conditions or actions of individuals and result in human error or an unsafe situation. Personnel factors refer to the crew resource management and personal readiness factors that affect practices, conditions or actions of individuals, and result in human error or an unsafe situation.

Environmental Factors

Physical Environment: Refers to factors that include both the operational setting (e.g., weather, altitude, terrain) and the ambient environment (e.g., heat, vibration, lighting, toxins).

Technological Environment: Refers to factors that include a variety of design and automation issues including the design of equipment and controls, display/interface characteristics, checklist layouts, task factors and automation.

Condition of Operators

Adverse Mental State: Refers to factors that include those mental conditions that affect performance (e.g., stress, mental fatigue, motivation).

Adverse Physiological State: Refers to factors that include those medical or physiological conditions that affect performance (e.g, medical illness, physical fatigue, hypoxia).

Physical/Mental Limitations: Refers to the circumstance when an operator lacks the physical or mental capabilities to cope with a situation, and this affects performance (e.g., visual limitations, insufficient reaction time).

Personnel Factors

Crew Resource Management: Refers to factors that include communication, coordination, planning, and teamwork issues.

Personal Readiness: Refers to off-duty activities required to perform optimally on the job such as adhering to crew rest requirements, alcohol restrictions, and other off-duty mandates.

HFACS Level 3: Unsafe Supervision

The Unsafe Supervision level is divided into four categories.

Inadequate Supervision: The role of any supervisor is to provide their staff with the opportunity to succeed, and they must provide guidance, training, leadership, oversight, or incentives to ensure the task is performed safely and efficiently.

Plan Inappropriate Operation: Refers to those operations that can be acceptable and different during emergencies, but unacceptable during normal operation (e.g., risk management, crew pairing, operational tempo).

Fail to Correct Known Problem: Refers to those instances when deficiencies are known to the supervisor, yet are allowed to continue unabated (e.g, report unsafe tendencies, initiate corrective action, correct a safety hazard).

Supervisory Violation: Refers to those instances when existing rules and regulations are willfully disregarded by supervisors (e.g., enforcement of rules and regulations, authorized unnecessary hazard, inadequate documentation).

HFACS Level 4: Organisational Influences

The Organisational Influences level is divided into three categories.

Resource Management: Refers to the organisational-level decision-making regarding the allocation and maintenance of organisational assets (e.g., human resources, monetary/budget resources, equipment/facility recourse).

Organisational Climate: Refers to the working atmosphere within the organisation (e.g., structure, policies, culture).

Operational Process: Refers to organisational decisions and rules that govern the everyday activities within an organisation (e.g., operations, procedures, oversight).

1.2.1. HFACS analysis

The research identified 1289 individual causal and contributory 340 human factors responsible for these CFIT accidents. These causal and 341 contributory human factors were extracted as HFACS nanocodes (Table 2.2), with each nanocode categorized under HFACS sub- categories within the overall HFACS framework of the four main levels of failure: Unsafe Acts, Pre-Conditions for Unsafe Acts, Unsafe Supervision, and Organizational In fluences.

Analyzed CFIT accident reports characteristics.

CFIT accident reports:

- 20 from general aviation;

- 8 from military aviation;

- 22 from commercial aviation;

Percentage of rotary & fixed wing analysis:

- 41 fixed wing;
- 9 rotary wing;

Types of operations:

- 21 passenger flights;
- 7 private flights;
- 5 medical flights;
- 5 cargo;
- 5 survey flights;
- 7 multi-role flights;

Phase of flight:

- 24 CFIT during the approach phase;
- 22 CFIT during the en-route phase;
- 4 CFIT during the departure phase;

Type of impact:

- 24 Mountain;
- 18 level ground;
- 8 water;

The number of sub-category occurrences per report provide a true representation of the analysis. This is evident where certain sub categories such as “Mental States” and “Communication, Coordination and Planning” have 14 and 12 defined factors, respectively, that may occur per report, compared to that of “Perceptual Errors” that contains only one factor. The analysis revealed that some accidents contain a much higher number of sub-categorical errors. In order to avoid the over misrepresentation of any single accident, it was determined that each sub-category would initially be counted once per accident where it occurred. The four levels of HFACS failure (colour-coded) for the analyzed accidents are illustrated in Fig. 2.3, with the percentage breakdown of occurrences as indicate Unsafe acts Decision, Skill-Based and Perceptual Errors are all common errors in CFIT accidents.

Elements of Decision and Skill-Based errors both occurred in 98% of the analyzed reports with Perceptual Errors representing 74% of reports. The most common types of decision error were, “The Assessment of Risk during the Operation” and the “Ignoring of a Necessary Action”.

This “Assessment of Risk during the Operation” error occurs in real time when formal risk assessment procedures are not possible. Flight crews were unable to make the appropriate decisions during flight in order to maintain a safe operating condition. This can be due to a number of reasons such as perceived pressure, distraction, inexperience, complacency, and lack of knowledge. While the reports list inexperience as a contributing factor, both airline interviewees stated that pilots who become complacent, despite considerable experience, are more commonly at fault in CFIT issues. In accident report number 24 for example, the weather continued to deteriorate, where the decision to continue into cloud, without adequate evaluation of the risks involved, led to an unsafe situation and ultimately, a terrain impact. “Ignoring a Necessary Action” was a factor, as a caution or warning was perceived and understood by the flight crew but was ignored leading to an unsafe situation.

This error represented a major decision-making factor in CFIT accidents that was identified in 40% of analyzed 383 reports. For example, in accident number 23, as the aircraft approached high terrain a ground proximity warning sounded to alert the crew, however, it was ignored intentionally and resulted in a collision with terrain. “Procedural Errors” and the “Breakdown of the Visual Scan” of the flight crew were skill-based errors that occurred in 72% and 84% of the reports, respectively. “Procedural Errors” occurred either when a procedure was accomplished in the incorrect sequence, when the incorrect technique was used or the incorrect control/switch was selected. “Procedural Errors” may also occur while conducting navigation, calculation or during the operation of automated systems by the flight crew. Diverging from a published set procedure can have serious consequences for the safety of a flight. In report number 45, while on approach to an airport located near high terrain, the aircraft unintentionally, failed to maintain the published approach procedure and diverted from their track, impacting with mountainous terrain. The “Breakdown in Visual Scan” refers to the flight crews' inadequate visual analysis of the aircraft's flight instruments. Flight crews failed to execute effectively learned internal or external visual scan patterns in 84% of reports. This is a basic flight skill that is constantly required throughout all flights in order to maintain a safe flight condition. It was evident in a total of 42 analyzed reports that, through distraction, complacency or lack of skill, a critical parameter such as altitude was ignored and an unsafe situation occurred. “Perceptual Errors” were prevalent in 74% of the analyzed reports.

This type of error represents a major factor in CFIT accidents when misperception of an object, threat or situation results in human error. “Perceptual Errors” include visual, auditory, vestibular illusions, and attention failures. These errors were evident in 37 reports and occurred when a member of the flight crew acted, or failed to act, based on an illusion, misperception or disorientated state, resulting in an unsafe situation. Sixteen of those thirty-seven reports occurred while the aircraft flew under VFR and inadvertently entered cloud in IMC. As evident in reports 30 and 36, the transition from external visual references to internal instruments, with no external references, had an adverse effect on the senses of the human body resulting in a misperception that ended in a terrain impact. Specialized training is required to handle adequately this state of flight. Procedural compliance can be viewed as a strong mitigating factor in the avoidance of CFIT. This assumption is supported by opinions expressed by airline A interviewees where both respondents reported that focussing on crews following correct procedures as defined by the company, act as a large barrier to CFIT occurrences. These procedures are not only emphasized and conditioned through strict training procedures but also through check flights and simulator training every 6 months. In a commercial aviation context, the airline B interviewee stated that they would view aircraft in visual meteorological conditions, while on an approach, being more at risk of committing a violation, as some pilots will tend to continue flight on receiving an alert or warning. If they are operating in IMC a go-around (GA) is more likely to be conducted as the option of continuing with no visual contact with the ground is available. A “sink rate” or “windshear” warning on an approach is an automatic GA situation; some pilots, however, were inclined to continue due to visual ground contact. The accident investigator interviewee stated that this “tunnel vision” draws pilots in to inadequately assessing the risk involved with continuing the approach and through this flawed decision-making process, decide to continue flight. Violations represent the wilful disregard for rules and instructions. While evident in less than 50% of the analyzed reports, a noteworthy discovery arose when comparing both “Routine” and “Exceptional” violations results. Routine violations represent the calculated or systemic violation of policy or procedure, whereas “Exceptional Violations” represent an intentional violation due to a lack of discipline. A larger percentage of routine violations occurred in military aviation. This variation between routine and exceptional military violations can be explained through the military's rigid disciplinary culture that is instilled in military personnel resulting in lower “exceptional” or “lack of discipline” violations while they may also be more open to being guided by colleagues and committing a routine violation that has be come a norm amongst peers. This can be due to the fluid nature of flight that at times, requires calculated, accepted routine violations of procedures in order to complete a task, often with lives at risk compared to that of an intentional lack of discipline. The organizational structure is not present in the majority of “General Aviation” accidents and therefore a lower percentage of intentional violation is experienced.

1.4 Brief introduction to the methods used to collect and analyze data

System analysis

System analysis - the study of a complex process in order to improve its efficiency.

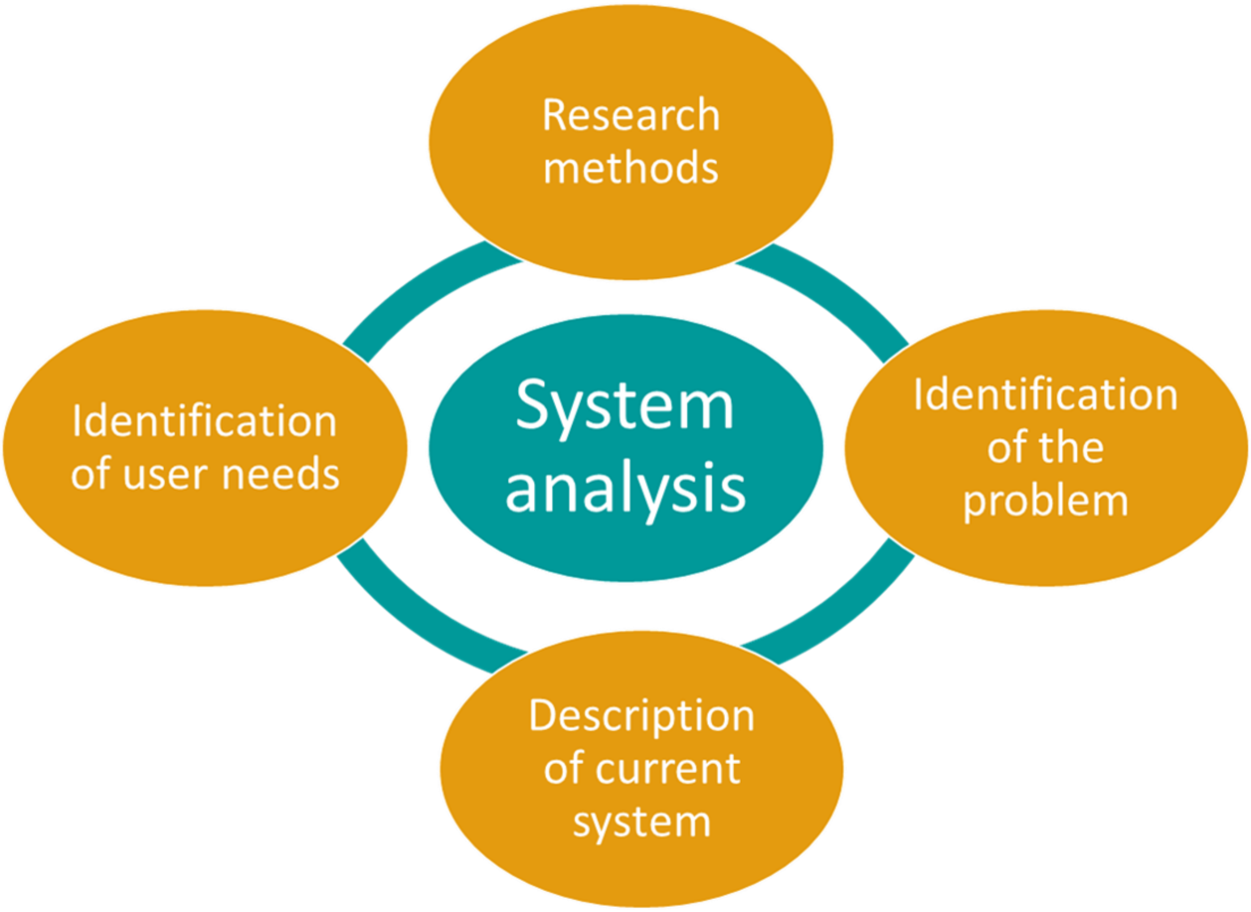

Fig. 1.3. System analysis

Research methodology is the specific procedures or techniques used to identify, select, process, and analyze information about a topic.

A problem is a situation that is unsatisfactory and causes difficulties for people.

Description of the current system is an explanation of the functionality, algorithms of its work, objects that interact with it.

Identifying user needs are aspects of the current system that require improvements or new features.

Research methods. Data collection methods

Interview

It's used to obtain information from person through oral responses. Interviewing is useful because...

facts can be gathered directly from the people who have direct experience of the present system;

full and detailed answers can be obtained by pursuing particular lines of questioning.

Advantages

Ask experts;

Collection of primary information;

Can easily add extra questions.

Disadvantages

Time-consuming: setting up, interviewing, transcribing, analysing, feedback, reporting;

Different interviewers may understand and transcribe interviews in different ways.

Questionnaires

Questionnaire is an instrument for collecting data, which almost always involves asking a given subject to respond to a set of oral or written questions.

Questionnaires enable the same set of questions to be asked to many people. A carefully designed questionnaire can be a very quick and cheap way to obtain specific answers to specific questions from a large number of people.

Advantages

Questionnaires are inexpensive;

Quick way to get results;

Respondent anonymity;

You gather information from a large audience.

Disadvantages

Dishonest answers;

Unanswered questions;

Differences in understanding and interpretation;

Lack of personalization.

Observation

Observation of the current practice enables current methods of working to be examined and necessary exceptions to the normal pattern of working to be noted. It is both a physical and a mental activity. Observation is purposive and not casual.

Examples:

A scientist looking at a chemical reaction in an experiment;

A zoologist watching lions hunting;

A fan watching a baseball game.

Advantages

Reliable and objective;

Natural setting;

No need of equipment or tool;

Useful for individuals as well as groups;

Immediate detection of problems;

Easy to complete, saves time;

Can be used in natural or experimental settings.

Disadvantages

Some of the occurrences may not be open to observation;

Not all occurrences lend themselves to observational study;

Lack of reliability;

Slow investigation;

Expensive.

Examination of documentation

Examination of the existing paperwork, documentation, records and procedure manuals can be used to identify the data that is used in the current system, the information that is produced by the current system and the procedures that are carried out.

Physical Evidence allows you to get information about past events, the observation of which is no longer possible. It can be articles, reports, user guides

Examples:

Flyers, posters, agendas, handbooks, and training materials, personal documents

Advantages

efficient and effective way of gathering data because documents are manageable and practical resources;

documents are stable, meaning that they can be read and reviewed multiple times.

Disadvantages

require some investigative skills;

small amount of useful data;

too much extra information.

Data analysis techniques

Analyzing Quantitative Data

Quantitative data is defined as the value of data in the form of counts or numbers where each data-set has an unique numerical value associated with it.

Associated with numbers;

Implemented when data is numerical;

Collected data can be statistically analyzed;

Examples: Height, Weight, Time, Price, Temperature, etc.;

Advantages

Produce in-depth analysis;

Specific themes and patterns identified;

Rich data leading to further research.

Disadvantages

Data very hard to analyse/ generalise results;

Lack of objectivity as affected by researchers view.

Analyzing Qualitative Data

Associated with details; Implemented when data can be segregated into well-defined groups; Collected data can just be observed and not evaluated; Examples: Scents, Appearance, Beauty, Colors, Flavors, etc.

Advantages

Conduct in-depth research;

Minimum bias;

Accurate results.

Disadvantages

Restricted information;

Depends on question types

CHAPTER 2

ANALYSIS OF HUMAN FACTORS IN CFIT INCIDENTS

2.1. Provide a detailed examination of the human factors contributing to CFIT incidents

CFIT is the second most common category of fatal accidents, after Loss of Control In-Flight (LOCI). CFIT accidents have been identified as mainly catastrophic events with 91% of CFIT accidents in 2010 to 2014 118 involving fatalities (IATA, 2014). Maurino (1992) and ICAO (1995) identified human error as a major causal factor in CFIT accidents, thus determining that human factor analysis is key to the investigation of CFIT accidents. CFIT accident fatalities since 1931 have been estimated at 30,000 people (Cooper, 1995). These accidents mainly occur in two de fined phases of flight; cruise and approach. The approach phase accounts for just a 4% portion of a flight, however, it is responsible for 50% of all CFIT accidents (Matthews, 1997). CFIT occurs most commonly during the approach and landing phase. CFIT has numerous factors that can be attributed to human error. For example, it is commonplace for flight crews in CFIT accidents to have a causation factor attributed to them known as “lack of situational awareness” (Phillips, 1999). Situational awareness (SA) can be defined as the perception, understanding, and ability to forecast the factors affecting the aircraft at any moment in time (Wick field, 1997).

It is essentially a pilot's ability to retain an accurate mental model, in three-dimensional space of the aircraft's position, altitude, speed, and prediction of the aircraft's future path, etc. Loss of SA can occur due to poor workload management, con flicting information, weather conditions, lack of aircraft systems knowledge, and inadequate planning. An increased reliance on automation is also viewed as a major contributing factor. Aircraft automation exists to aid flight crew in conducting a safer flight. Complacency and a lack of vigilance, when system monitoring is required, can result in a loss of SA with devastating consequences. This complacency can be attributed to the human operators over dependence on an aircraft's automated systems (Endsley, 1995). In order to maintain good SA, a pilot must be attentive and perceptive at all stages of the flight. Preventative measures can be implemented through thorough pre-flight planning, improving manual flight skills , and maintaining a high-level of specific aircraft mechanical and avionics knowledge. One of the most famous instances of losing SA 149 was the American Airlines flight 965 in Cali, Columbia in 1995 where experienced pilots entered the incorrect data into the flight management system (FMS) which resulted in CFIT into a mountain (NTSB, 1995). Loss Q4 of SA is one of the most common human factors attributed to CFIT accidents (Cooper, 1995; Gore, 1997; Scott, 1996; Wick field, 1997). Other factors that also have an effect, according to IATA (2014) are:

- Non-compliance with established Standard Operating Procedures 156 (SOPs).
- Inadequate flight path management.
- Lack of vertical and/or horizontal position awareness in relation to terrain.
- Un-stabilized approaches.
- Failure to initiate a go-around when required.
- Conducting operations in poor weather conditions.
- Incorrect action/response by flight crew.
- Failure in Crew Resource Management (CRM) such as cross-checking, communications, coordination, leadership, etc.

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Complacency and a lack of vigilance, when system monitoring is required, can result in a loss of SA with devastating consequences. This complacency can be attributed to the human operators over dependence on an aircraft's automated systems (Endsley, 1995). In order to maintain good SA, a pilot must be attentive and perceptive at all stages of the flight. Preventative measures can be implemented through thorough pre-flight planning, improving manual flight skills, and maintaining a high-level of specific aircraft mechanical and avionics knowledge. One of the most famous instances of losing SA was the American Airlines flight 965 in Cali, Columbia in 1995 where experienced pilots entered the incorrect data into the flight management system (FMS) which resulted in CFIT into a mountain (NTSB, 1995). Loss Q4 of SA is one of the most common human factors attributed to CFIT accidents (Cooper, 1995; Gore, 1997; Scott, 1996; Wick field, 1997). Other factors that also have an effect, according to IATA (2014) are: • Non-compliance with established Standard Operating Procedures (SOPs). • Inadequate flight path management. • Lack of vertical and/or horizontal position awareness in relation to terrain. • Un-stabilized approaches. • Failure to initiate a go-around when required. • Conducting operations in poor weather conditions. • Incorrect action/response by flight crew. • Failure in Crew Resource Management (CRM) such as cross-checking, communications, coordination, leadership, etc.

Table 2.1 Reports analyzed

Flight cat	A/C reg	A/C make	A/C model	Type of operation	A/C damage	Fatalities	Phase of flight	Impact	VMC/IMC	Light	Pilot in control
Commercial	9 N-AHH	Twin Otter	VIKING DHC6 –400)	Pax Transfer	Destroyed	23	En Route	Mountain	IMC	Night	Co-Pilot

Military	49–3043	Raytheon U-125	Hawker 800	Multi Role Transport	Destroyed	6	En Route	Mountain	IMC	Day	Co-Pilot
General Avionic	RA-33462	Antonov 2SX	2SX	Survey	Destroyed	2	En Route	Level Ground	VMC	Day	Captain
General Avionic	N208SD	Cessna	208D Grand Caravan	Pax & Cargo Transfer	Destroyed	3	En Route	Mountain	IMC	Day	Co-Pilot
Helicopter Military	HKP14D	NH Industries	NH90 (Formation)	Multi Role Transport	Damaged	0	En Route	Frozen Lake	VMC	Day	Captain
Commercial	PK-YRN	Aerospatial	ATR 42–300	Pax Transfer	Destroyed	54	En Route	Mountain	IMC	Night	Captain
General Avionic	N757ZM	Cessna	Cessna 152	Pax Transfer	Destroyed	1	En Route	Level Ground	IMC	Day	Captain
Commercial	D-AIPX	Airbus	A320	Private	Destroyed	150	En Route	Mountain	VMC	Day	Co-Pilot
Helicopter Military	168,792/SE-08	Bell	UH-1Y Huey	Pax Transfer	Destroyed	13	En Route	Mountain	IMC	Day	Captain
General Aviation	N8749A	Beech	A35	Medical	Destroyed	2	En Route	Mountain	IMC	Day	Captain
General Aviation	BFU1	Cessna	Citation 501	Private	Destroyed	4	Approach	Level Ground	IMC	Day	Captain

Commercial	B-22810	Aerospatial	ATR 72	Pax Transfer	Destroyed	48	Approach	Level Ground	IMC	Day	Captain
General Aviation	EP-FIC	Dassault	Falcon 20E	Pax Transfer	Destroyed	4	Approach	Water	VMC	Day	Captain
General Aviation	N248SP	Piper	PA-46	Aerial Survey	Destroyed	1	Departure	Mountain	IMC	Night	Captain
Helicopter GA	G-LABL	Augusta Westland	AW139	Private	Destroyed	4	Departure	Level Ground	VMC	Night	Captain
Commercial	N155UP	Airbus	A300	Pax Transfer	Destroyed	2	Approach	Level Ground	IMC	Day	Captain
Helicopter GA	C-GCFU	Bolkow	Bo105	Cargo	Destroyed	3	En Route	Water	VMC	Night	Captain
General Aviation	N9078X	Cessna	182D	Survey	Destroyed	2	Approach	Mountain	VMC	Night	Captain
Helicopter GA	C-GIMY	Sikorsky	S-76A	Private	Destroyed	4	Departure	Level Ground	VMC	Day	Captain
Commercial	RDPL-4223	Aerospatial	ATR 72	Medical	Destroyed	49	Approach	Water	IMC	Day	Captain
Military	6840	Douglas	Dakota C47	Multi Role Transport	Destroyed	11	En Route	Mountain	IMC	Day	Captain
Military	5630	Lockeed Martin	Hercules C130	Multi Role Transport	Destroyed	5	En Route	Mountain	IMC	Day	Captain

Commercial	97,004	Sukjoi	RRJ-95	Pax Transfer	Destroyed	45	En Route	Mountain	IMC	Day	Captain
General Aviation	VH-CWQ	Cessna	Cessna 182	Private	Destroyed	1	En Route	Mountain	IMC	Day	Captain
Commercial	AP-BKC	Boeing	737–200	Pax Transfer	Destroyed	127	Approach	Level Ground	IMC	Day	Captain
Helicopter Comm	C-GQCH	Sikorsky	S-92	Pax Transfer	No Damage	0	Departure	Water	IMC	Night	Captain
Commercial	PK-MZK	Xian	MA60	Pax Transfer	Destroyed	25	Approach	Water	VMC	Night	Captain
General Aviation	VH-LKI	Piper	Saratoga PA-32	Private	Destroyed	3	Approach	Level Ground	VMC	Day	Captain
Commercial	EC-ITP	Fairchild	Metro III SA 227	Pax Transfer	Destroyed	6	Approach	Level Ground	IMC	Day	Co-Pilot
Commercial	PK-TLF	Airbus	CASA 212	Pax Transfer	Destroyed	18	En Route	Mountain	IMC	Day	Captain
Military	101	Tupelov	TU-154 M	Multi Role Transport	Destroyed	96	Approach	Level Ground	IMC	Night	Captain
Commercial	PT-GKQ	Embraer	EMB-110P	Cargo	Destroyed	0	Approach	Mountain	IMC	Day	Captain
Commercial	N455A	De Havilland	DHC-3 T	Pax Transfer	Destroyed	5	En Route	Mountain	VMC	Day	Captain
Commercial	5A-ONG	Airbus	A330-200	Pax Transfer	Destroyed	103	Approach	Water	IMC	Day	Captain
Commercial	AP-BJB	Airbus	A321	Pax Transfer	Destroyed	152	Approach	Mountain	IMC	Day	Captain

Military	265	Pilatus	PC-9M	Pilot Training	Destroyed	2	En Route	Water	VMC	Night	Captain
Helicopter HEMS GA	N911LZ	Eurocopter	EC145	Medical	Destroyed	0	Approach	Mountain	IMC	Day	Captain
Helicopter GA	C-GNLK	Bell	206	Survey	Destroyed	6	En Route	Level Ground	VMC	Day	Captain
General Aviation	8Q-MAG	De Havilland	DH6	Survey	Destroyed	20	En Route	Level Ground	IMC	Day	Captain
Commercial	PK-BRD	British Aerospace	BAE-146	Cargo	Destroyed	0	Approach	Water	VMC	Night	Captain
Military	19	Airbus	CASA 295	Multi Role Transport	Destroyed	1	Approach	Mountain	IMC	Night	Captain
Helicopter GA	C-GIMR	Sikorsky	S-76A	Medical	Damaged	9	Approach	Mountain	VMC	Night	Captain
Air Taxi Part 135 Comm	N410NB	Hawker Beechcraft	1900C	Cargo	Destroyed	3	Approach	Mountain	VMC	Day	Captain
General Aviation	ZS-OSD	Brriten Norman	Islander	Pax Transfer	Destroyed	3	En Route	Mountain	IMC	Day	Captain
Commercial	YV102T	Boeing	737	Pax Transfer	Destroyed	57	Approach	Mountain	IMC	Night	Captain
General Aviation	N45MF	Beechcraft	200	Medical	Destroyed	1	Approach	Mountain	VMC	Night	Captain

Commercial	TC-AKM	McDonnell Douglas	MD-83	Pax Transfer	Destroyed	6	Approach	Mountain	IMC	Night	Captain
Commercial	N1116Y	Cessna	208B	Cargo	Damaged	3	Approach	Level Ground	IMC	Day	Captain
Commercial	Ra-65,421	Tupelov	134A-3	Pax Transfer	Destroyed	6	Approach	Level Ground	IMC	Day	Captain
General aviation	N364KW	Beechcraft	A36TC Bonanza	Private	Destroyed	3	En Route	Mountain	IMC	Day	Captain

Evolution of frameworks, most important of which are the Human Factors Analysis and Classification System (HFACS), the Systems Theoretic Accident Modelling and Processes (STAMP) model, Dupont Human Performance Model, Accimap, Pilot Competencies Model. The Systems Theoretic Accident Modelling and Processes (STAMP) model is a constraints-based model that uses control theory to describe the interaction between system components and the implemented controls used within a specific system (Leveson, 2004). In accident analysis, STAMP generates a description of a specific systems control structure where it then identifies failures within this structure that were factors in the accident (Leveson, 2012). The Dupont Human Performance Model, also known as Dupont's Dirty Dozen includes 12 defined human error elements that act as precursors to accidents. According to Dupont (1997). communication; (2) Lack of teamwork; (3) Lack of knowledge; (4) Lack of awareness; (5) Lack of assertiveness; (6) Lack of resources; (7) Fatigue; (8) Pressure; (9) Complacency; (10) Stress; (11) Distraction and (12) Norms. This model, having been created for aircraft maintenance, was subsequently adapted for use amongst all personnel in volved with aviation.

The Dupont model was also used by ICAO (1995) in their investigation of specific CFIT accidents in 2014. Accimap is used to graphically illustrate system failures, decisions and specific acts that are involved in an accident (Rasmussen, 1997). This approach differs from other accident analysis techniques by identifying causal factors from all parts of the system in which the accident took place. This ranges from the physical sequence of events and activities of the individuals involved, right up to the causes at the governmental, regulatory, and societal levels. Unlike other methods for accident analysis, this approach also assembles the contributing factors into a coherent causal diagram that illustrates the interrelationships between them, thereby highlighting the problem areas that should be addressed to prevent similar accidents from occurring in the future. This process is useful for highlighting the organizational and systemic inadequacies that contributed to the accident, so that attention is not directed solely towards the events and human errors that led direct to the accident. The Dupont model does not offer a comprehensive list of human error accident precursors. The model has been widely utilized across the aviation maintenance industry allowing future use in other sectors of aviation.

While the model has deficiencies, it could be developed or used in conjunction with another model when investigating aviation accidents. This is also the case with the "Pilot Competencies Model" where a comprehensive list of factors is lacking, however, it can be purposefully utilized with another model. Both STAMP and Accimap can be viewed as cumbersome and time consuming when applied to complex aviation investigations. Leveson (2012) suggested that STAMP does not lend itself to a simple graphical representation of an accident. While HFACS is time consuming it was specifically designed for the investigation of aviation accidents and is more consistent due to its use of classifications and nanocodes (Salmon, Cornelissen and Trotter, 2011). Human Factors Analysis and Classification System (HFACS) model was created to address the difficulty of applying Reason's Swiss Cheese Model in a practical manner (Lower, Magott, & Skorupski, 2018; Wiegmann and Shappell, 1996; Wiegmann & Shappell, 2017). Wiegmann and Shappell (2001, 2003, 2005) investigated the reasons surrounding U.S. naval aviation accidents and tried to identify how to reduce the accident rate. Traditional accident investigation techniques were not sufficiently applicable to identify key aspects of human factors throughout the various accidents. Therefore, the Human Factors Analysis and Classification System (HFACS) was developed. Ultimately, the goal of HFACS is not to attribute blame, rather to understand the underlying causal factors that led to an accident (Wiegmann and Shappell, 2000).

Wiegmann and Shappell (2003) acknowledged that the Swiss Cheese Model identified that the defence barriers of an organization could be breached to ultimately permit a hazard to become an accident. They decided that the layers required labelling in order to be classified into an acceptable structure (Wiegmann and Shappell, 2003). This resulted in respective layers being identified as four defined layers that allowed for the exact methods of failure for each level to be determined more definitively, as illustrated in Fig. 1 . HFACS classified the layers of the framework as Unsafe Acts, Pre Conditions for Unsafe Acts, Supervisory Failures and Organizational In fluences (Wiegmann and Shappell, 2003). Within each level of HFACS, causal sub-categories were outlined (Table 3) that could identify the active and latent failures that occur with greater accuracy. The sub-categories explained above are then dissected into "nanocodes. " For example, skill-based errors are sub-divided into breakdowns in visual scan, inadvertent use of flight controls, poor technique/airmanship, over or under-controlling the aircraft, omitting a checklist item, omitting a step in a procedure, over reliance on automation, failing to prioritize attention, task overload, negative habit, failure to see and avoid, distraction, etc. (Wiegmann and Shappell, 2003). It has been suggested that it may be possible to supplement the use of HFACS with less laborious analytical methods if conducting multiple minor investigations (ICAO, 1993).

2.2 Cockpit Ergonomics and Human-Machine Interface

Current flight deck automation has improved the safety and efficiency of commercial aviation but a broad consensus has developed over the last 20 years that this technology is deficient in some areas. It has been developed in an ad hoc manner and without a human centered approach; leading to problems regarding the human/machine interaction and adversely impacting decision making throughout the flight. Current procedures and design do not give automation liability although it has great authority and autonomy during most phases of flight. Cockpit automation has not been designed in such a way to provide adequate and unambiguous feedback to the human operator as to its current and intended actions.

More or different training is the most common response to this problem but has failed to fully compensate for the design flaws in current automated systems. Accidents that cite pilot error do not always acknowledge how difficult it is for human operators to overcome fundamental, system level, flaws in the design of the machines they work with. This paper proposes some changes in cockpit automation design that will improve the vigilance of the pilots and therefore create better decision-making. Numerous accident and incident reports have been cited by regulatory authorities when making changes in automated flight operation regulations. This reflects a “reactive” approach to FAA automated flight safety guidelines and highlights the need for an improved governance system in the cockpit. This paper also provides a literature review for current studies on human-machine interaction related to the cockpit.

The FAA defines aeronautical decision making (ADM) as the “Systematic approach to the mental process used by aircraft pilots to consistently determine the best course of action in response to a given set of circumstances”. The FAA places ADM in the broader context of risk management. Noyes, discussed the impact of complex automation on existing models of ADM. She stated “too much automation, and the human operator is not in the loop when failures and malfunctions occur. Making decisions thus becomes problematic as crew are not fully aware of the situation.” She further elaborated by saying “the challenge for system design concerns the development of systems, which provide an appropriate level of automation for a particular situation at a given time.” Two Design Philosophies, Boeing vs. Airbus Boeing and Airbus dominate manufacturing of large commercial transport aircraft today and their design choices have great influence over other makers and tend to set standards. Boeing introduced the glass cockpit 757 and 767 in the early 1980’s and committed the company to using analogue gauges only in a supporting role. They updated the 737 and 747 models with glass cockpits and introduced the fly-by-wire 777 and 787.

These advances in technology allowed aircraft to navigate using satellites and on-board equipment. This brought performance-based navigation (PBN), which reduced average flight times, improved fuel efficiency, and is widely credited with reducing accident rates compared to air transports only operating with ground-based sensors for navigation guidance Airbus introduced the first fly-by-wire airliner in 1988 with their A320. This approach provides flight envelope protections which limit the pilot’s input when these place potentially damaging G forces on the airframe or lead to an angle of attack that would cause a stall to manifest. This technology also lowered maintenance costs and reduced training times. Boeing and Airbus each have published automation philosophies; the key difference being that Boeing takes a more pilot centric approach. In both designs, automation will override or resist the pilot at the outer limits of the flight envelope. Airbus has a marginally greater number of these override systems and they activate slightly sooner. Airbus uses a sidestick while Boeing uses a traditional yoke. This yoke uses a stick shaker during a pre-stall event and will push forward automatically if a stall manifests. The sidestick does not do this and they are also not slaved to each other as the yokes are and thus one pilot cannot know what inputs the other pilot is applying. When the aircraft is operating in full automation, the Boeing throttles and yokes move to reflect inputs from the autopilot but the sidestick and throttles in an Airbus do not move while under autopilot control. Airbus recently received a patent for a design featuring a windowless cockpit as seen in Figure 1

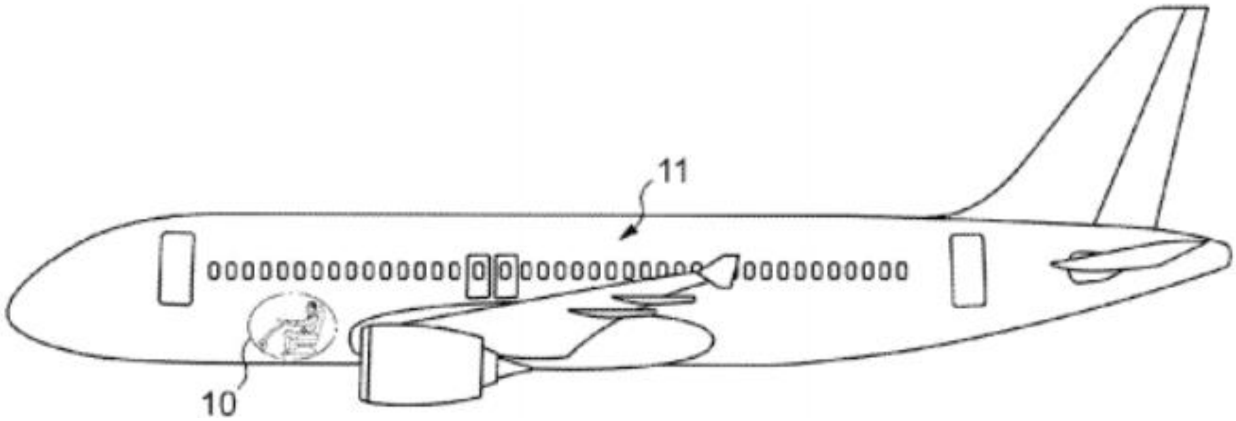


Figure 2.1. Airbus' new design to eliminate pilot's natural vision (U.S. Patent No.2014/0180508A1, 2014)

Problems with the Current Flight Deck Previous research on problems with cockpit automation fall into one of several categories. Automation has impacted workload by lowering workload where it was already low and increasing it where it was already high. Various working groups comprising all or most major stakeholders in commercial transport aviation conclude workload is reduced during normal operations but can increase in non-normal circumstances such as a last-minute runway change from Air Traffic Control (ATC) as use of the automated systems may increase task complexity and workload on the pilots. Pilots can lose their cognitive model of what the plane is doing while under automated control and this leads to a phenomenon called automation surprises. This situation awareness issue is sometimes more narrowly focused in the literature as mode confusion referring to the many possible mode configurations in the FMS.

A common concern in studies over the last 20 years is the degradation of manual flying skills of pilots who operate their aircraft at a high level of automation during most phases of flight. How to improve training to help pilots better utilize automation is a topic of long standing but more recently Geiselman, Johnson, & Buck emphasized that better training is only a partial solution and they call for “a more contextaware automation design philosophy that promotes a more communicative and collaborative human-machine interface.” The autopilot systems in use have a myriad of possible configurations, which makes it difficult for the pilot to understand what mode is in force at any given time. A diagram of these modes is shown in Figure 2.2.

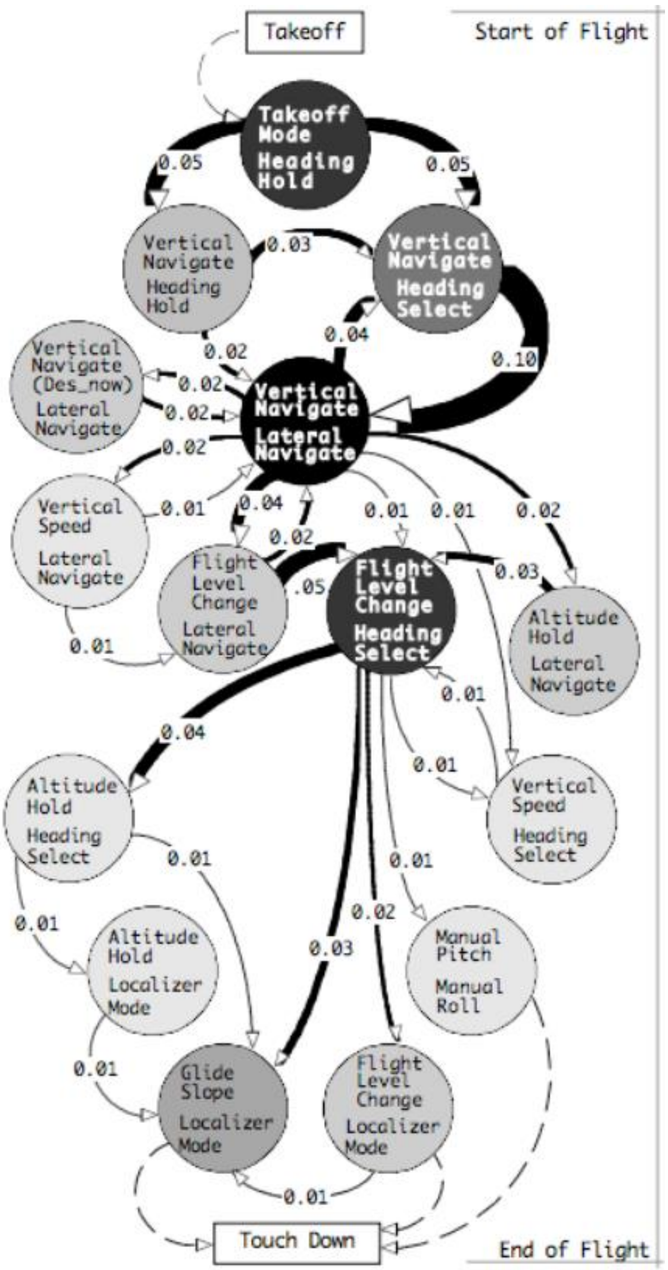


Figure 2.2. Diagram of various autopilot mode configurations over the course of a flight. “Modes in automated cockpits: problems, data analysis, and a modeling framework”, Degani, Shafto, & Kirlk, (1996)

Need Input from Automation to Improve Pilot’s Situational Awareness and Vigilance

When considering broadly how to improve safety and efficiency in commercial aviation, making automation more of a team player should be a primary goal. The process of updating avionics is lengthy and the question arises of how to improve the automation system without making an entire redesign, which would be costly, time consuming, and require much additional training. Some add-on applications should be considered to make improvements until basic design changes can be created and implemented to update current automated systems. Several fatal commercial aviation crashes including Air France 447, Air Asia 8501, Asiana 214, and Colgan Air 3407 have shown that a large obstacle to pilots applying their airmanship skills is automation dependency and overreliance. Once automation had reached its performance limits, it can abruptly disconnect and shift total responsibility to the pilots, often with little or no guidance as to the last state of the aircraft. Sometimes pilots are confused over the course of routine flights as automation can lead to them being out of the control loop. Cockpit voice recordings reveal comments such as "what is it doing now?", "are we descending or ascending?", and "I don't understand why it's pitching up", etc. If a supplemental piece of automation is provided that helps the pilots maintain awareness of aircraft state, this could help them act correctly and swiftly when they must suddenly take manual control of their aircraft. A survey conducted amongst airline pilots clearly makes us believe that automation has made the pilot's life easier (75 out of 77 survey respondents said this) but the same survey revealed that 37% of pilots are sometimes surprised by the actions automation takes. We believe if pilots are engaged with their aircraft throughout the flight, it will improve safety and therefore more research is needed in this direction.

2.3 Presentation of data analysis results that illustrate trends and patterns in CFIT incidents related to human errors

The research identified 1289 individual causal and contributory human factors responsible for these CFIT accidents. These causal and contributory human factors were extracted as HFACS nanocodes (Table 2.2), with each nanocode categorized under HFACS sub categories within the overall HFACS framework of the four main levels of failure: Unsafe Acts, Pre-Conditions for Unsafe Acts, Unsafe Supervision, and Organizational In fluences.The number of sub-category occurrences per report provide a true representation of the analysis. This is evident where certain sub categories such as "Mental States" and "Communication, Coordination and Planning" have 14 and 12 defined factors, respectively, that may occur per report, compared to that of "Perceptual Errors" that contains only one factor. The analysis revealed that some accidents contain a much higher number of sub-categorical errors. In order to avoid the over misrepresentation of any single accident, it was determined that each sub-category would initially be counted once per accident where it occurred. The four levels of HFACS failure (colour-coded) for the analyzed 358 accidents are illustrated in Fig. 2.3, with the percentage breakdown of occurrences as indicated. This would allow for the Dupont Model and Pilot Competencies Model to be used in conjunction with HFACS. It has also been suggested, that in the majority of incident investigations, HFACS is only required for more in-depth human factors analysis of more serious, or specific, incidents (Liu, Sun, and LV, 2011). HFACS supports a data collection and categorization process that can be applied both during and post-accident investigation (Stolzer and Goglia, 2016).

Table 2.2 Highest scoring sub-categories and corresponding nanocodes

Sub-category	Nanocodes	Count
Decision errors	Risk assessment - during operation	45
	Task misprioritization	19
	Necessary action - rushed	2
	Necessary action - delayed	13
	Necessary action - ignored	20
	Decision-making during operation	44
Skill-based errors	Inadvertent operation	4
	Checklist error	10
	Procedural error	36
	Overcontrol/undercontrol	21
	Breakdown in visual scan	42
Physical environment	Vision restricted by meteorological conditions	44
	Vision restricted in workspace by dust/smoke etc.	1
	Windblast	1
	Thermal stress - cold	1
	Thermal stress - heat	0
	Manoeuvring forces - in flight	11
	Lighting of other aircraft	3
	Noise interference	1
	Brownout/whiteout	1
Mental states	Pre-existing personality disorder	0
	Pre-existing psychological disorder	1
	Pre-existing psychosocial problem	1
	Emotional state	6
	Personality style	7
	Overconfidence	18

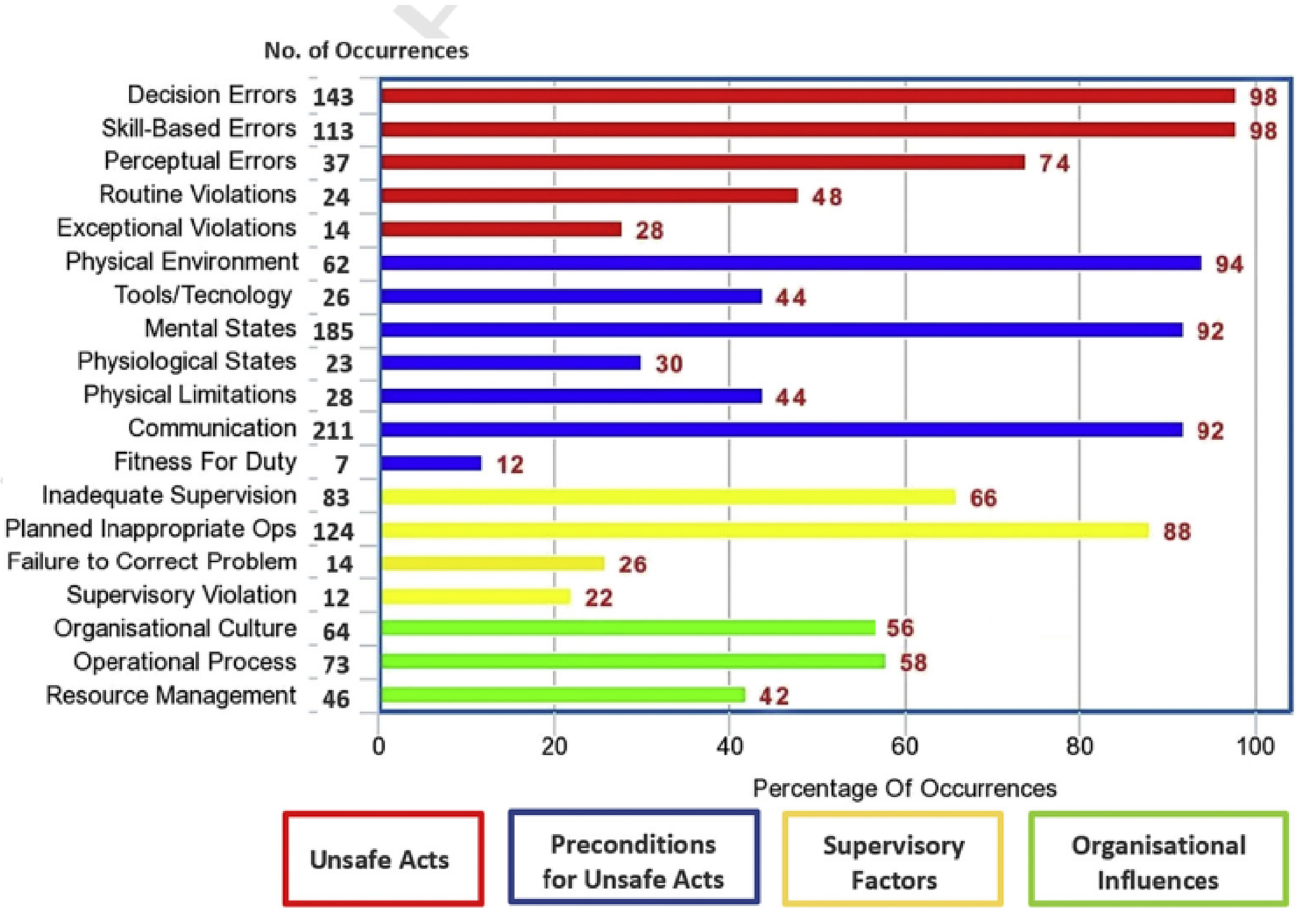
	Pressing	25
	Complacency	30
	Inadequate motivation	2
	Misplaced motivation	1
	Overaggressive	7
	Excessive motivation to succeed	34
	Get-home-it is/get-there-it is	30
	Response set	20
	Motivational exhaustion (burnout)	4
Coordination/communication/planning factors	Crew/team Leadership	28
	Cross-monitoring performance	32
	Task delegation	10
	Rank/position authority gradient	10
	Assertiveness	18
	Communication critical information	15
	Standart/proper terminology	12
	Challenge and reply	10
	Mission planning	38
	Mission briefing	30
	Task/mission-in-progress re-planning	41
	Miscommunication	12
Inadequate supervision	Leadership/supervision/oversight inadequate	25
	Supervision – modelling	4
	Local training issue/programs	20
	Supervision – policy	24
	Supervision – personality conflict	4
	Supervision – lack of feedback	6
Planned inappropriate operations	Ordered/led on mission beyond capability	8
	Crew/team/flight makeup/composition	13
	Limited recent experience	18
	Limited total experience	14
	Proficiency	32
	Risk assessment – formal	29
	Authorized unnecessary hazard	10
Organizational culture	Unit/organizational values/culture	17
	Evaluation/promotion/upgrade	3
	Perception of equipment	3

	Unit mission/aircraft/vehicle/equipment change or unit deactivation	11
	Organizational structure	2
Operational process	Ops tempo/workload	13
	Program and policy risk assessment	14
	Procedural guidelines/publications	12
	Organizational training issues/programs	12
	Doctrine	2
	Program oversight/program management	13

This is closely related to two other nanocode elements, “excessive motivation to succeed” and “get-home-itis.” “Excessive Motivation to Succeed,” evident in 68% of the reports analyzed, was a factor when the flight crew was preoccupied with the success of the mission, to the exclusion of other mission factors. “Get home-itis,” evident in 60% of the reports analyzed, and specifically, report 44, was a factor when a crew was motivated to reach a mission goal/destination for personal reasons, thereby cutting short necessary procedures or exercising poor judgement. These three “Mental States” factors highlight the pressure that was felt by flight crews to reach a destination in 92% of CFIT reports analyzed, while forcing the aircraft into an unnecessary unsafe situation. “Complacency” was a factor when a member of the flight crew has a state of reduced conscious attention, due to an attitude of overconfidence, under motivation or the sense that the situation is “under control.”

This was a factor in 60% of reports where the cockpit gradient was high and one member of the crew was considerably more experienced than the other. This situation led to decisions not being assessed or questioned correctly which, ultimately led to a chain of unsafe events. Flight crews with considerable experience became overconfident and over reliant on an aircraft's automated systems, which inflicted a reduced state of conscious attention on the flight parameters, required for a safe flight condition. Commercial flight reports analyzed represented over 70% of the complacency instances, however the average captain hours were over 14,000 h of flight experience.

The flight safety manager interviewee stated that there were similar experience issues encountered with both of their recent CFIT accidents in 1999 and 2008, which have highlighted the importance of training and crew flying currency to them "Cross-monitoring Performance" is essential to achieve an efficiently operating flight crew. Despite this, "Cross-monitoring Performance" was identified as an issue in 62% of reports when crewmembers failed to monitor or assist in necessary cockpit actions and decisions. Thirty-two analyzed accident reports encountered cross-monitoring issues on entering cloud or at night where effective instrument monitoring was of the utmost importance in order to achieve safe flight conditions. "Mission Planning" and "Briefing" by flight crews were identified as deficient in 72% and 60% of reports. Planning was a factor when information and instructions provided to crews was insufficient, or crews failed to discuss contingencies for strategies if required. For example, this occurred in report number 21 where, the inadequate preflight plan, unintentionally resulted in the incorrect flight level being filed with ATC for the cruise phase of flight. The aircraft then cruised at a lower, unsafe level, resulting in an impact with mountainous terrain. The air accident investigator interviewee highlighted the importance of proper planning, especially when utilising automated systems, with the last two CFIT occurrences in Ireland both containing planning de ficiencies.



Picture 2.3 HFACS occurrences.

Briefing" was determined to be closely related to planning when information and instructions provided to crews was insufficient or crews also failed to discuss strategies to handle contingencies. A lack of adequate briefing was highlighted in 60% of CFIT accident reports. This pre-flight preparation is a proven method to provide awareness and readiness to the crew for the planned mission. More importantly, this procedure highlights any unexpected issues that may arise such as worse than expected weather, alternate airports, etc. While a mission may have been appropriately briefed prior to departure, "Mission-in-Progress Re-planning" was noted with high occurrence of 81%. Crewmembers failed to adequately reassess changes in their dynamic environment during a mission and alter their mission plan accordingly in order to ensure the adequate management of risk was provided. This was often related to perceived pressures on the crew, mission fixation, and complacency

CHAPTER 3

Problems and proposals for reducing the human factor in aviation accidents

3.1 Problems that arise in HFACS occurrences

Every error has some reason, in this section we will analyze most of the causes of errors associated with the human factor and try to give recommendations on how to eliminate or reduce them. from picture 2 we see common causes of errors and based on it we will describe it in more detail.

Decision Errors

Decision errors occur when individuals make incorrect or suboptimal choices due to various factors. These factors may include bias, incomplete information, emotions, time pressure, and uncertainty. Decision errors can lead to undesirable consequences both in professional and personal life.

Skill-Based Errors - Skill-based errors occur when individuals possess the necessary knowledge and skills to perform a task correctly, but still make mistakes due to slips, lapses, or other failures in execution. These errors often occur during routine or repetitive tasks and can be caused by various factors such as distraction, fatigue, stress, or environmental conditions. Unlike decision errors, which involve the cognitive aspect of decision-making, skill-based errors primarily relate to the execution or performance of a task. Examples include pressing the wrong button on a control panel, misreading a gauge, or forgetting a step in a well-known procedure. These errors can have consequences ranging from minor inconveniences to serious accidents, depending on the context in which they occur.

Perceptual Errors-

Perceptual errors occur when individuals misinterpret or misperceive sensory information, leading to inaccurate perceptions of reality. These errors can result from factors such as poor visibility, inadequate lighting, ambiguous stimuli, or physiological limitations. Perceptual errors can affect decision-making, problem-solving, and overall understanding of a situation. Examples include misjudging distances, misinterpreting facial expressions, or misidentifying objects.

Routine Violations –

Routine violations occur when individuals intentionally deviate from established procedures or norms in a habitual manner. Unlike occasional mistakes or errors, routine violations involve a consistent disregard for rules or standards. These violations often stem from factors such as perceived inefficiency of procedures, time pressure, or a belief that the violation will not result in negative consequences. However, routine violations can undermine safety, efficiency, and reliability in various contexts, including workplaces, transportation systems, and healthcare settings.

Exceptional Violations –

"Exceptional violations" refers to situations where standards or rules are breached under exceptional circumstances, such as emergencies or extreme necessity. These violations may be necessitated by the need for quick response to unforeseen situations or the desire to preserve lives or avoid threats to safety. However, even in such cases, exceptional violations should be minimized and assessed considering their consequences and possible alternative courses of action.

Physical Environmental

"Physical Environmental" typically refers to the natural or built surroundings that affect living organisms and human activities. This encompasses various elements such as air, water, landforms, vegetation, climate, and human-made structures. In discussions about the environment, physical environmental factors often include considerations like pollution levels, biodiversity, climate change, and sustainability practices.

Tools/Tecnology –

Problems that may arise with tools and technology can vary and depend on the context of their use. This includes malfunctions and breakdowns, obsolescence, unsatisfactory performance, safety concerns, usability issues, integration complexity, and cost. Malfunctions or breakdowns in technological devices can lead to temporary or prolonged work interruptions. Rapid technological advancements may render tools and devices obsolete, necessitating frequent updates or replacements. Some tools or technologies may not meet required performance standards or satisfy user needs. Incorrect use of tools or technology can lead to unsafe working conditions or pose health risks to users. Certain technologies may be complex to use or require specialized skills or knowledge, creating challenges for users. Integrating new technologies with existing systems or processes may be complex and lead to compatibility issues or decreased performance. Investing in new tools and technologies can be costly, and expenses related to staff training and equipment maintenance can also increase overall costs.

Mental States-

"Mental states" refer to various psychological conditions, moods, or states of mind that individuals experience. These can include emotions like happiness, sadness, anger, or fear, as well as cognitive states such as attention, memory, perception, and reasoning. Mental states also encompass broader concepts like motivation, beliefs, attitudes, and personality traits. Understanding mental states is crucial in fields such as psychology, psychiatry, neuroscience, and cognitive science, as they play a significant role in shaping human behavior, decision-making, and overall well-being.

Physical Limitations

"Physical limitations" refer to various constraints that may arise due to the physical characteristics or condition of the human body. These limitations can include restricted mobility due to injury or illness, limited vision or hearing capabilities, as well as physical constraints associated with aging. Physical limitations can impact one's ability to perform certain tasks, engage in various activities, or participate in social life, and may require different adaptive strategies or assistive devices to facilitate daily living.

Communication

"Communication" is the process of exchanging information, ideas, thoughts, or feelings between individuals or groups. This exchange can occur through various methods such as spoken or written language, gestures, facial expressions, body language, or visual aids. Effective communication involves both transmitting and receiving information accurately, as well as understanding and interpreting the message being conveyed. Communication plays a vital role in interpersonal relationships, teamwork, decision-making, education, and virtually all aspects of human interaction and society. Bad communication can occur for various reasons. For instance, lack of clarity in expressing thoughts or using complex language can hinder understanding. It's also important to consider the audience's needs and emotional state. Inability to listen properly or misunderstanding nonverbal signals can also create issues. Cultural differences, stress, and limited time for communication can also have a negative impact. Overall, poor communication can lead to misunderstanding, conflicts, and reduced effectiveness in communication.

Fitness For Duty –

"Fitness for Duty" is a concept used to determine an employee's ability to perform their job duties according to established standards and requirements. This means that the employee must be physically, emotionally, and cognitively capable of carrying out their responsibilities without posing a risk to themselves, colleagues, or the employer. Assessing fitness for duty may involve medical checks, psychological evaluations, competency testing, and job performance evaluations. This concept is often employed in professional fields where safety and reliability are paramount, such as military service, aviation, healthcare, and industry.

Problems related to "Fitness for Duty" can encompass various issues. Employees may face medical problems, such as physical or psychological issues, that hinder their ability to perform job duties safely. Substance abuse can also impair their effectiveness and jeopardize workplace safety. Psychological conditions like depression or anxiety can affect work performance. Fatigue and stress from overwork or challenging situations can lead to decreased productivity. Additionally, employees lacking qualification or training may pose risks to themselves and others. Health issues, including chronic illnesses or injuries, can limit task performance. Furthermore, unprofessional behavior or ethical breaches can undermine trust and job competency. Addressing these issues through regular assessments and appropriate interventions is vital for maintaining safety and productivity in the workplace.

Inadequate Supervision –

"Inadequate supervision" refers to a situation where the oversight provided to employees or activities within an organization is insufficient or ineffective. This lack of supervision can lead to various issues such as decreased productivity, errors, safety hazards, and a decline in overall performance. It may occur due to factors like a shortage of supervisory staff, insufficient training for supervisors, poor communication between supervisors and employees, or a failure to establish clear expectations and guidelines. Inadequate supervision can have detrimental effects on organizational outcomes and may result in increased risks, lower morale among employees, and a negative impact on the organization's reputation. Therefore, ensuring adequate supervision is essential for promoting accountability, maintaining standards, and achieving organizational goals.

Planned Inappropriate Ops-

Planned Inappropriate Ops can create a host of problems within an organization. When operations are planned and executed without due regard for established norms and regulations, it can lead to a cascade of negative consequences. Firstly, there's the risk of safety breaches, where employees or the environment may be put in harm's way due to shortcuts or disregard for safety protocols. This not only jeopardizes the well-being of individuals but can also result in legal ramifications and hefty fines if regulations are violated.

Moreover, such actions can tarnish the organization's reputation, leading to a loss of trust from clients, stakeholders, and the public. This loss of trust can have far-reaching effects, impacting customer retention, partnerships, and even investor confidence. Additionally, the financial fallout from these missteps can be significant, ranging from immediate financial losses due to operational disruptions or legal penalties to long-term damage caused by reputational harm.

In essence, Planned Inappropriate Ops undermine the integrity of the organization, erode trust, and pose serious risks to its sustainability. Therefore, it's imperative for organizations to prioritize ethical and compliant practices, ensuring that operations are conducted with integrity, adherence to regulations, and a commitment to safety and responsibility.

Failure to correct Problem –

"Failure to correct problem" - it's when an organization fails to take necessary measures to address identified issues or deficiencies. This can happen for various reasons, such as lack of awareness of the problem, ineffective management processes, or reluctance to make changes. Regardless of the reason, it can lead to additional complexities and negative consequences, such as loss of trust from stakeholders, additional costs, and loss of competitiveness. Preventing this situation requires a systematic approach to problem management, active detection and timely response, as well as a culture of openness and readiness for change within the organization.

Supervisory Violation –

"Supervisory Violation" refers to a situation where a supervisor or manager fails to adhere to established policies, procedures, or ethical standards while overseeing employees or operations within an organization. This can include actions such as favoritism, harassment, discrimination, neglect of duties, or failure to address employee concerns or grievances. Supervisory violations can have serious consequences, including damage to employee morale, legal liabilities, and harm to the organization's reputation. It's essential for supervisors to uphold high standards of professionalism, fairness, and integrity in their interactions with employees and in the execution of their supervisory responsibilities. Violations of supervisory authority can lead to serious problems. Firstly, there is a loss of trust from employees due to unfair or unethical behavior by the supervisor, which can decrease their motivation and productivity. Secondly, there may be legal consequences, including legal proceedings, fines, and damage to the company's reputation. Thirdly, the negative impact on the company's reputation, both internally and externally, can harm the brand and the business as a whole. Additionally, such actions can cause qualified employees to leave and decrease productivity. Finally, dissatisfaction and disorganization within the organization can reduce business efficiency and deter clients and partners, resulting in revenue loss and market share decline.

Organisational Culture –

"Organizational culture" refers to the shared values, beliefs, relationships, and behaviors that characterize an organization and guide the interactions and decisions of its members. It encompasses the ways things are done within the organization, including norms, rituals, symbols, and communication patterns. Organizational culture plays a significant role in shaping employee behavior, influencing job satisfaction, productivity, and overall organizational effectiveness. Its formation can be influenced by various factors such as leadership style, organizational structure, industry norms, and historical context. A strong and positive organizational culture can foster employee engagement, innovation, and adaptability, while a negative or dysfunctional culture can hinder organizational effectiveness and employee morale. Therefore, understanding and managing organizational culture are important for achieving strategic goals and creating a healthy work environment. Problems associated with organizational culture may include conflicts of values, employee dissatisfaction, lack of innovation, communication issues, decreased productivity, talent loss, and negative impact on company reputation. These issues can arise from mismatches between organizational culture and employee expectations, inadequate support for innovation, unclear communication processes, or lack of motivation among staff. Addressing these problems requires attention to fostering a positive and supportive culture and building an open and inclusive work environment.

Operational Process-

"Operational Process" refers to the series of activities or steps that an organization follows to achieve its objectives and deliver its products or services. It encompasses the procedures, workflows, and methods employed to execute tasks efficiently and effectively within the organization. Operational processes typically involve various stages, such as planning, implementation, monitoring, and evaluation, and they may span multiple departments or functions within the organization. These processes are essential for ensuring consistency, quality, and performance in the delivery of goods or services and for optimizing the organization's overall efficiency and effectiveness.

Problems with operational processes encompass inefficiencies, quality issues, increased costs, production or supply delays, lack of flexibility, safety concerns, low customer satisfaction, and compliance issues. These challenges can arise from poorly designed or unoptimized processes, inadequate planning or management, and insufficient adaptability to changing conditions or customer needs. Addressing these problems requires careful evaluation, redesign, and implementation of operational processes to ensure efficiency, quality, safety, and compliance while meeting customer expectations and business objectives.

Resource Management –

"Resource Management" involves the effective allocation, utilization, and optimization of various resources within an organization to achieve its goals and objectives. These resources may include human resources (employees), financial resources (budgets, funding), physical resources (equipment, facilities), and intangible resources (knowledge, technology). Effective resource management involves identifying resource needs, planning resource allocation, acquiring necessary resources, monitoring resource usage, and optimizing resource utilization to maximize productivity, efficiency, and overall organizational performance. Proper resource management ensures that resources are utilized efficiently, costs are minimized, and organizational objectives are achieved effectively.

Problems associated with resource management may include insufficient resources to perform tasks, inefficient resource allocation, inadequate planning and underutilization of resources, coordination issues among different parts of the organization, and a lack of change management. Addressing these issues requires careful planning, efficient resource utilization, coordinated management, and ongoing monitoring and analysis of resource management processes.

3.2 Suggestions to mitigate problems

Now we will try to give some recommendations for each case.

Errors in decision-making often stem from limited information, time pressure, or biases. To mitigate these, structured decision-making processes should be developed, encompassing goal definition, alternative analysis, risk assessment, and criteria for success.

Utilizing data and analytics is pivotal in enhancing decision quality. Effective data collection, analysis, and interpretation help identify trends, evaluate risks, and make informed decisions. Collective decision-making can reduce errors by incorporating diverse perspectives and experiences. Discussing decisions and exchanging views fosters a deeper understanding of the issue and leads to more thoughtful decisions. Continuous training and development in decision-making methods and analytical skills are essential for improving decision quality.

Lastly, it's crucial to acknowledge that decision-making errors are inevitable. Learning from them and using them as lessons to enhance decision-making processes in the future is imperative.

Solutions to address issues related to skill-based errors may include:

Training and coaching: Implementing systematic training and coaching sessions for employees to develop the necessary skills and abilities, enabling them to perform tasks more efficiently and accurately.

Standardization of processes: Developing standardized procedures and workflows that are simple and clear for employees can reduce the likelihood of errors stemming from ambiguous or unclear instructions.

Implementation of decision support: Developing tools or systems that provide employees with the necessary information and support for decision-making can help them avoid errors due to insufficient information or incorrect assessments of the situation. Employee support: Creating a supportive and empathetic work environment where employees feel comfortable seeking assistance and guidance can reduce stress and enhance productivity, thereby lowering the likelihood of errors.

Continuous learning and feedback: Conducting regular training sessions and providing feedback on task performance allows employees to continually improve their skills and avoid repeating mistakes in the future. Analysis of operational events: Analyzing incidents and errors to identify root causes and taking corrective actions can help prevent the recurrence of similar situations in the future. These solutions can be effective in reducing the occurrence of skill-based errors and improving overall productivity and quality of work.

Perceptual Errors-

Training and awareness initiatives aim to educate employees about various perceptual distortions and methods to mitigate them, including recognizing stereotypes, biases, and emotional influences in decision-making. Actively seeking diverse perspectives in decision-making processes reduces the likelihood of unnoticed perceptual distortions, fostering a more comprehensive understanding of the situation. Collaborative decision-making in group settings encourages discussion and analysis, aiding in the identification of potential perceptual errors. Verification and confirmation procedures require employees to actively check their perceptions before making important decisions, such as seeking additional information or double-checking data. Leveraging modern technologies like machine learning algorithms and data analytics automates processes and detects potential distortions, enhancing decision-making accuracy. Providing feedback on decision quality and analyzing effectiveness helps employees recognize and prevent perceptual errors in the future.

Exceptional Violations –

To address issues related to exceptional violations, several approaches can be applied. Root cause analysis involves conducting thorough analyses of the reasons and circumstances surrounding exceptional violations to identify key factors contributing to their occurrence. Training and educational programs can be implemented to raise awareness among employees about rules, standards, and procedures, as well as develop decision-making skills in non-standard situations. Improvement of standards and procedures entails reviewing and updating standard procedures considering exceptional circumstances and potential risks, along with providing clear instructions on actions to take in emergency situations. Support and resources should be provided to employees, including necessary resources, tools, and equipment to effectively address problems in exceptional situations. Feedback and case-based learning are essential, involving organizing training sessions, analyzing, and discussing cases of exceptional violations to extract lessons and develop strategies to prevent similar situations in the future. Establishing a safety culture and accountability is crucial, where every employee feels responsible for adhering to standards and procedures, as well as for addressing problems in emergency situations. These approaches aim to enhance employees' readiness to handle exceptional situations and reduce the likelihood of exceptional violations by increasing awareness, training, and improving standards and procedures.

Physical Environmental - To address issues related to the physical environment, several solutions can be implemented. Firstly, conducting regular inspections and maintenance of facilities and equipment can help identify and mitigate potential hazards or deficiencies. Secondly, implementing ergonomic designs and workstation setups can improve comfort and safety for employees, reducing the risk of injuries or discomfort. Thirdly, implementing environmental controls such as proper ventilation, temperature regulation, and lighting can create a more conducive work environment, enhancing employee well-being and productivity. Additionally, providing adequate training and awareness programs on workplace safety and environmental hazards can empower employees to identify and address issues proactively. Finally, establishing clear protocols and emergency procedures for handling environmental emergencies such as fires, chemical spills, or natural disasters can ensure swift and effective responses to mitigate risks and minimize damage. These solutions collectively contribute to creating a safer and healthier physical environment for employees, fostering a positive work environment and improving overall organizational performance.

Tools/Tecnology-

To address issues related to tools and technology, several solutions can be implemented. Firstly, investing in regular maintenance and upgrades of tools and technology can help ensure their functionality and reliability. This includes scheduling routine inspections, repairs, and updates to address any issues promptly and prevent future problems. Secondly, providing comprehensive training and support to employees on the proper use and troubleshooting of tools and technology can enhance their effectiveness and efficiency in utilizing these resources. Thirdly, implementing robust cybersecurity measures to protect against cyber threats, data breaches, and system vulnerabilities is essential in safeguarding sensitive information and maintaining operational continuity. Additionally, fostering a culture of innovation and continuous improvement can encourage employees to provide feedback, suggest improvements, and collaborate on optimizing tools and technology for better performance. Finally, establishing contingency plans and backup systems in the event of tool or technology failures can minimize disruptions and ensure business continuity. These solutions collectively contribute to maximizing the benefits of tools and technology while minimizing risks and challenges associated with their use.

Mental States- To address issues related to mental states, several solutions can be implemented. Firstly, promoting mental health awareness and destigmatizing mental health challenges in the workplace can encourage employees to seek support when needed and create a supportive environment. This can be achieved through educational programs, workshops, and open discussions about mental well-being.

Secondly, offering access to mental health resources and support services, such as counseling, therapy, or employee assistance programs, can provide employees with avenues for seeking help and managing mental health concerns effectively.

Thirdly, implementing stress management and resilience-building programs can equip employees with coping strategies and tools to navigate stressors and challenges more effectively, thereby promoting overall well-being and reducing the risk of mental health issues. Additionally, fostering a culture of work-life balance and promoting healthy lifestyle habits, such as regular exercise, adequate sleep, and mindfulness practices, can contribute to maintaining positive mental states among employees. Moreover, providing leadership training and support for managers to recognize signs of mental distress in their teams and facilitate open communication can help address issues early and provide appropriate support to those in need. Finally, establishing clear policies and procedures for accommodating mental health needs and promoting a culture of inclusivity and support can create a psychologically safe workplace where employees feel valued, respected, and empowered to prioritize their mental well-being.

Physical Limitations –

To address issues related to physical limitations, several solutions can be implemented. Firstly, conducting workplace assessments to identify physical barriers and obstacles that may impede the mobility or accessibility of employees with physical limitations. Implementing ergonomic workplace designs and accommodations, such as adjustable desks, ergonomic chairs, and assistive devices, can help alleviate physical strain and discomfort for employees. Providing training and awareness programs for all employees to foster understanding and sensitivity towards colleagues with physical limitations. This includes education on inclusive communication, respectful behavior, and appropriate ways to offer assistance or support. Implementing flexible work arrangements and job accommodations to accommodate the unique needs of employees with physical limitations. This may include telecommuting options, modified work schedules, or job restructuring to ensure equal opportunities for participation and advancement.

Additionally, establishing clear policies and procedures for requesting and implementing workplace accommodations, as well as providing support and resources for employees with physical limitations to navigate these processes effectively.

Moreover, promoting a culture of diversity, inclusion, and accessibility within the organization can create a supportive environment where employees feel valued, respected, and empowered to contribute their talents and perspectives regardless of physical abilities.

Finally, ongoing evaluation and feedback mechanisms can help identify areas for improvement and ensure that physical limitations are effectively addressed and accommodated in the workplace.

Communication - To overcome communication problems, various methods can be applied. Foremost, it is important to create an atmosphere of openness and trust where employees feel comfortable expressing their thoughts and ideas. This can be achieved by conducting training sessions on communication skills and encouraging active listening among employees.

Next, it is essential to establish clear communication channels and procedures for information dissemination within the company. This includes using various communication tools such as email, video conferencing, internal chats, and regular meetings. Involves supporting interpersonal communication and conflict resolution. Managers can assist employees in resolving conflicts and provide training on constructive interaction.

Additionally, implementing feedback systems and evaluating communication effectiveness can help identify problem areas and develop action plans for improvement.

Fostering team spirit and understanding the goals and values of the organization contribute to more effective communication and collaboration among team members.

To address issues related to fitness for duty, several measures can be taken. Firstly, regular medical check-ups and screenings should be conducted to ensure the physical and mental well-being of employees. This will help identify potential issues early and take necessary actions. Secondly, access to health and well-being support programs and counseling services for employees should be provided. This may include consultations with psychologists, resilience training, and programs to improve physical fitness. The third step is to ensure a safe and healthy work environment. This involves adhering to all occupational health and safety standards, providing necessary personal protective equipment, and conducting training sessions on injury prevention. Additionally, training programs and workshops aimed at raising awareness among employees about the importance of physical and mental readiness for work are crucial. Finally, management should actively promote and encourage a healthy lifestyle among employees, such as providing access to fitness facilities, organizing yoga classes or other sports activities, and supporting a healthy eating policy in the workplace.

Inadequate Supervision-

To address issues of inadequate supervision, several strategies can be implemented. Firstly, enhancing training programs for supervisors can provide them with the necessary skills and knowledge to effectively manage their teams. This training should focus on leadership, communication, conflict resolution, and performance management. Secondly, implementing regular performance reviews and feedback mechanisms can help identify areas where supervision may be lacking. This allows for timely intervention and corrective actions to be taken. Thirdly, promoting a culture of open communication and transparency within the organization can encourage employees to voice their concerns and seek assistance when needed. Supervisors should be approachable and accessible to provide guidance and support to their team members. Additionally, establishing clear expectations and goals for supervisors and providing them with the resources and support they need to succeed can help ensure effective supervision. Finally, fostering a supportive and collaborative work environment where teamwork is valued can help mitigate issues of inadequate supervision. Encouraging collaboration and peer support can provide additional layers of supervision and assistance when needed.

Planned Inappropriate Ops

To address problems related to planned inappropriate operations, several solutions can be considered. Firstly, implementing robust checks and balances within the planning process can help identify any inappropriate or unethical actions beforehand. This involves involving multiple stakeholders in the planning phase and conducting thorough risk assessments to anticipate potential negative consequences. Secondly, establishing clear policies and guidelines for operations can help ensure that all activities are aligned with organizational values and objectives. These policies should outline ethical standards, legal requirements, and acceptable practices to guide decision-making and behavior. Thirdly, providing comprehensive training and education to personnel involved in planning and executing operations is essential. This training should emphasize ethical decision-making, critical thinking, and adherence to established protocols. Additionally, fostering a culture of accountability and transparency within the organization can encourage employees to speak up about any concerns regarding planned operations. Encouraging open communication channels and whistleblower protection mechanisms can provide avenues for reporting and addressing inappropriate activities. Furthermore, conducting regular audits and reviews of operational procedures can help detect any deviations from established norms and address them promptly. These audits should be conducted by independent parties to ensure impartiality and objectivity. Overall, addressing planned inappropriate operations requires a multifaceted approach that involves proactive planning, clear policies, comprehensive training, a culture of accountability, and ongoing monitoring and review.

Failure to correct Problem

To effectively address the issue of failure to correct problems, organizations can implement several strategies. Firstly, establishing clear processes and protocols for identifying and addressing issues promptly is essential. This includes defining roles and responsibilities for problem resolution, establishing escalation procedures, and setting clear timelines for action. Secondly, fostering a culture of accountability and ownership among employees is crucial. Encouraging individuals to take responsibility for identifying and addressing problems in their areas of responsibility can help ensure that issues are not overlooked or ignored. Thirdly, providing adequate resources and support for problem-solving efforts is essential. This may involve allocating sufficient time, budget, and personnel to address issues effectively, as well as providing access to training and tools to facilitate problem-solving. Additionally, promoting open communication and collaboration within the organization can help facilitate the sharing of information and ideas for problem resolution. Creating forums for employees to discuss challenges, share best practices, and brainstorm solutions can foster a culture of continuous improvement. Furthermore, implementing systems for tracking and monitoring problem resolution efforts can help ensure that issues are addressed in a timely manner and that progress is being made. This may involve using technology such as issue tracking software or establishing regular review meetings to assess progress and adjust strategies as needed. Overall, addressing the issue of failure to correct problems effectively requires a proactive and systematic approach that involves clear processes, accountability, resource allocation, communication, and monitoring.

Organisational Culture

To address issues related to organizational culture, organizations can implement several strategies. Firstly, leaders should actively promote and model the desired culture by demonstrating behaviors aligned with the organization's values and objectives. This involves setting clear expectations and providing consistent messaging about the importance of the desired culture. Secondly, organizations can conduct cultural assessments to identify areas for improvement and areas of strength. This involves gathering feedback from employees through surveys, focus groups, or interviews to assess perceptions of the current culture and identify areas that may need attention. Thirdly, organizations can implement targeted interventions to shape and reinforce the desired culture. This may involve implementing policies and practices that support the desired cultural norms, providing training and development opportunities to help employees understand and embody the desired culture, and recognizing and rewarding behaviors that align with the desired culture. Additionally, fostering open communication and transparency within the organization can help ensure that employees understand the organization's values and feel empowered to contribute to shaping the culture. This may involve creating channels for feedback and dialogue, establishing forums for discussing cultural issues, and ensuring that leaders are accessible and approachable. Furthermore, leaders should be mindful of the impact of their own behavior on organizational culture and take steps to ensure that their actions are consistent with the desired culture. This may involve seeking feedback from employees, soliciting input from diverse perspectives, and demonstrating humility and openness to change. Overall, addressing issues related to organizational culture requires a multifaceted approach that involves leadership commitment, cultural assessments, targeted interventions, open communication, and ongoing monitoring and refinement. By taking proactive steps to shape and reinforce the desired culture, organizations can create an environment where employees feel valued, engaged, and motivated to contribute to the organization's success.

Operational Process

Address issues related to operational processes, organizations can implement several strategies. Firstly, they can conduct comprehensive reviews and analyses of existing processes to identify inefficiencies, bottlenecks, and areas for improvement. This involves mapping out current processes, identifying pain points, and collecting feedback from stakeholders. Secondly, organizations can standardize and streamline processes to improve efficiency and consistency. This may involve establishing standardized procedures, implementing automation tools or technologies, and reducing unnecessary steps or handoffs in the process. Thirdly, organizations can invest in training and development initiatives to ensure that employees have the necessary skills and knowledge to execute processes effectively. This may involve providing training on new technologies or systems, offering professional development opportunities, and fostering a culture of continuous learning. Additionally, organizations can leverage data and analytics to monitor and optimize operational processes in real-time. This may involve implementing performance metrics and KPIs to track process performance, analyzing data to identify trends and patterns, and using predictive analytics to anticipate and prevent potential issues. Furthermore, organizations can foster a culture of innovation and continuous improvement to encourage employees to identify and implement process enhancements. This may involve establishing cross-functional teams or task forces to brainstorm ideas, piloting new initiatives, and celebrating successes and lessons learned. Overall, addressing issues related to operational processes requires a systematic approach that involves reviewing, standardizing, training, leveraging data, and fostering a culture of innovation. By continuously refining and optimizing operational processes, organizations can improve efficiency, reduce costs, and enhance overall performance.

Resource Management

To address issues related to resource management, organizations can implement several strategies. Firstly, they can conduct a thorough assessment of their current resource allocation practices to identify areas of inefficiency or waste. This involves analyzing how resources such as finances, personnel, equipment, and time are currently being utilized and identifying opportunities for improvement. Secondly, organizations can prioritize resource allocation based on strategic objectives and performance goals. By aligning resource allocation decisions with organizational priorities, organizations can ensure that resources are being allocated to activities and initiatives that will drive the greatest value and impact. Thirdly, organizations can implement tools and technologies to improve resource planning and tracking. This may involve adopting project management software, resource planning tools, or enterprise resource planning (ERP) systems to better manage and allocate resources across projects and departments. Additionally, organizations can invest in training and development initiatives to improve resource management skills among employees. This may involve providing training on budgeting, forecasting, project management, and other relevant skills to help employees effectively manage resources and make informed decisions. Furthermore, organizations can establish clear communication channels and processes for resource allocation decisions. By involving relevant stakeholders in resource allocation discussions and ensuring transparency and accountability in decision-making processes, organizations can minimize conflicts and ensure that resources are allocated fairly and effectively. Overall, addressing issues related to resource management requires a strategic and systematic approach that involves assessing current practices, prioritizing resource allocation, leveraging tools and technologies, investing in training and development, and fostering clear communication and collaboration. By improving resource management practices, organizations can optimize resource utilization, enhance efficiency, and drive better outcomes.

CONCLUSION

This study underscores the critical need to understand and address human factors contributing to Controlled Flight Into Terrain (CFIT) incidents, which remain among the most lethal types of aviation accidents. Despite significant advancements in navigational aids and safety systems, CFIT accidents continue to occur, highlighting a substantial gap in the current aviation safety paradigm. By focusing on the human element of cockpit operations, specifically how pilots interact with these systems and make decisions under pressure, we can develop more effective training programs, improved cockpit design, and better regulatory practices.

The analysis reveals that CFIT incidents are often the result of complex interactions between technological, cognitive, and situational factors. Issues such as loss of situational awareness, inadequate communication, pilot fatigue, and failure to follow standard operating procedures play significant roles in these accidents. Additionally, the increasing complexity of cockpit environments and the introduction of new technologies necessitate ongoing research to ensure that safety training and regulations are based on the most current data and effective practices.

Addressing these human factors has significant implications not only for enhancing safety but also for reducing the economic and regulatory impacts of CFIT accidents. Improved pilot training and cockpit design can lead to substantial cost savings and mitigate the severe financial consequences for airlines.

Moreover, the comparison between Boeing and Airbus automation philosophies provides valuable insights into how different design choices influence pilot interaction with automated systems. Understanding these differences can inform future design improvements to better support pilot situational awareness and decision-making.

Ultimately, this study advocates for a more integrated and proactive approach to aviation safety, combining advanced technology with a deep understanding of human factors. By doing so, we can significantly reduce the likelihood of CFIT incidents and enhance the overall safety and efficiency of commercial aviation. Continued collaboration between regulatory authorities, manufacturers, and aviation professionals is essential to achieve these goals and ensure the highest standards of flight safety.

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