Analyzing the Threats of the Failure of Visual Awareness and Cognitive Bias During a Visual Approach for Commercial Operations

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Abstract

The purpose of this study is to conduct a detailed analysis of the limitation of visual awareness that flight crew experience while conducting visual approaches to an airport. Visual awareness is critical while conducting visual approaches and it is important to study the factors that can limit the capabilities of human beings to maintain visual awareness. This research will explore the limitations of visual awareness which special emphasis on change blindness, inattentional blindness, and visual masking. This study will also focus on forms of cognitive bias such as expectation and confirmation bias in the flight deck. Visual approaches expose pilots to multiple and critical visual stimuli that require strong visual awareness for safe operations. This research will explore visual approaches in commercial operations around the world and conduct a detailed analysis of the Flight Safety Foundation accident database to study the reported incidents during visual approaches in air carriers from 2008-2018. The effect of human factors will be studied in those incidents with special emphasis on the role of visual awareness and cognitive bias.

The results from the Flight Safety Foundation data is quantified and a trend analysis is carried out. Fatigue and distractions inside the cockpit such as annunciation and alerts during high task saturation periods are analyzed to be major factors for incidents during visual approaches. Enhanced Crew Resource Management (CRM) procedures and varying Standard Operating Procedures(SOPs) for different Flight Duty Periods(FDPs) are some of the recommended practices that were analyzed in the study.

Introduction

Visual awareness is critical while conducting visual approaches and it is important to study the factors that can limit the capabilities of human beings to maintain visual awareness.

Key Concepts Overview

- *Visual Awareness: "T*he subjective sensation of seeing something" (Wyart & Tallon-Baudry, 2008). Even though the retina of a human being might observe a stimuli, but might fail to perceive a salient visual stimuli.
- *Cognitive Bias:* Cognitive bias occurs when "human cognition reliably produces representations that are systematically distorted compared to some aspect of objective reality." (Hasleton, Nettle, & Murray, 2015) It can be described as a systematic error in thinking and judgment that affects the decision making of human beings.
- *Confirmation Bias*: "Seeking or interpreting of evidence in ways that are partial to existing beliefs, expectations, or a hypothesis in hand." (Nickerson, 1998)
- Expectation Bias: An individual's behavior, decisions, or actions are influenced by the individual's expectations from an event or entity.
- Inattentional Blindness: A failure of visual awareness where people fail to notice salient objects while looking right at them.
- *Change Blindness*: The inability to detect changes to an object or scene.
- *Visual Masking:* The reduced visibility of one stimulus, called target, due to the presence of another stimulus, called mask.

Visual Approach:

A visual approach is conducted on an Instrument Flight Rules (IFR) flight plan which authorizes the pilot to visually approach the runway while staying clear of clouds. The following conditions need to be met:

- The pilot needs to either have the preceding aircraft in sight of the airport in sight.
- Reported weather must be atleast 1,000 feet of ceiling and 3 Statute Miles of visibility.

Flight Safety Foundation reports that 41 percent of the 118 fatal approach-and-landing accidents from 1980 to 1996 involving jet aircraft with maximum takeoff weight above 12,500 pounds took place during visual approaches.

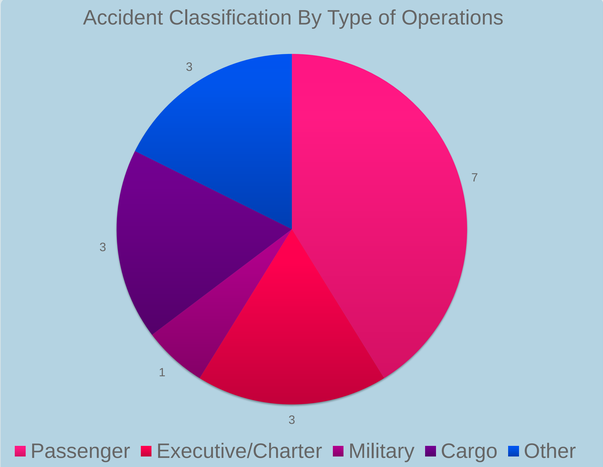
Methodology

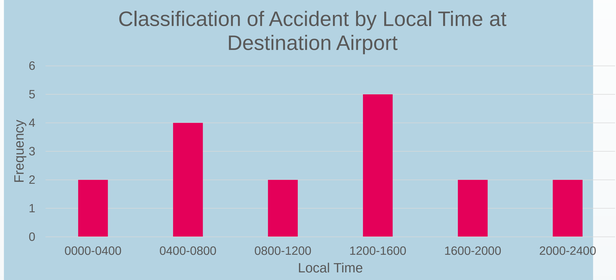
For the study, the aviation safety database of the Flight Safety Foundation was analyzed to study accidents in the period from 1998-2018 that occurred during a visual approach for commercial operations. For accuracy and relevance to the purpose of the research, data was further filtered to only include accidents that occurred due to human error that corresponded to visual awareness and cognitive bias. Factors such as alcohol impairment, equipment malfunction, incapacitation, and maintenance were not considered in the analysis. This allowed the researchers to analyze a small, yet relevant database to conduct a comprehensive analysis of the factors and events that lead to the accidents Each accident was analyzed individually and data was analyzed from the state aviation accident investigation report (National Transport Safety Board report).

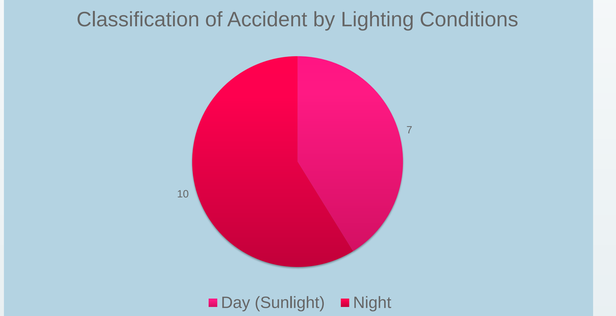
A total of 17 accidents were analyzed that occurred in different locations around the world during commercial operations in the period of 1998-2018.

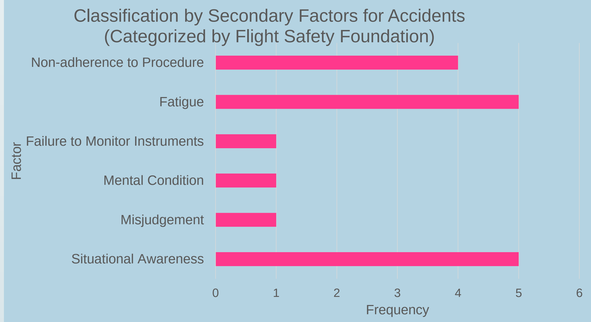
Results

Quantitative Analysis:









Qualitative Analysis

The following take-aways have been compiled by reviewing the reports from the state investigative agencies and Flight Safety Foundation.

- Fatigue and situational awareness were analyzed to be leading causes of accidents due to human errors that related to visual awareness and cognitive bias.
- Loss of visual references on final led to somatogravic illusions in 2 separate accidents.
- Flying a visual approach during periods of 'Low Circadian Levels' was analyzed to pose a major risk.
- Poor Crew Resource Management practices described as a major risk.
- Lack of simulator training for visual approaches considered a factor in accidents.
- Incomplete approach briefings were a major cause of subsequent errors during visual approaches.
- Geographical features around the airport play a role in developing illusions and misjudgment. For example, in the case of the Onus Air A321-231 crash on 26 September 2013, the visual segment of the approach was flown over an ocean which was deemed as a factor that led to the disorientation for the crew.
- Lack of visual references during the night led to disorientation and incorrect input by pilots during the visual approach.
- The effect of fatigue on perceptual vision and visual attention during visual approaches was analyzed as a factor.

Conclusion

The analysis of the accidents emphasized the enhanced role of situational awareness, task management, and crew resource management during visual approaches. Task saturation was identified as a secondary factor in multiple accidents during visual approaches.

The study emphasized the need for the following:

- Risk management procedures to identify 'high risk airports' and routes that consider flight duty periods, physiological factors such as 'Low Circadian Levels' during operations, and geographical features near the airport that could induce visual illusions.
- Enhanced simulator training and crew qualifications for conducting visual approaches at high risk airports.
- Fatigue risk management to study the risk of physiological factors on visual approaches.
- Enhanced crew resource management procedures during visual approaches at high risk airports.
- Improved education for pilots on the effects of cognitive bias on situational awareness.
- Improved approach briefings by flight crew to identify possible hazards to visual awareness and illusions.

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