

**Inattetional blindness and bias during visual scan**

**Capt. Amit Singh FRAeS**

## BIO

*Senior management professional with over 25 years of commercial aviation experience.*

*Amit has flown over 14000 hours on Boeing - 777 and Airbus - 320.*

*Currently flying the A-320 on line in the Middle East, Amit has held the posts of:*

*Chief of Safety, AirAsia*

*Director Flight Operations, AirAsia*

*Chief Pilot Training, Interglobe Aviation Ltd."IndiGo"*

*Amit has been speaking at Training and Safety forums globally. The main theme has been the importance of the basic knowledge level and higher order thinking in building the foundation of learning and safety.*

*Aviation blogger with human factors edge. <https://mindFly.blog/>*

### Abstract

Visual illusion is a perception of something existing in such a way as to cause misinterpretation of its true nature. It convinces us that the real life version of the object is untrue or false. The cognitive power of our brain can also create an effect of blindness wherein we do not see obvious and discernible objects in our visual field. In day-to-day life, the term used is “looking without seeing”. Aviation, marine, and automobile occurrences have been recorded that have an element of not sighting the obvious. Investigations in the past have not considered this aspect at all thereby, in a way linking the flight crew to the error. Cognitive ease prefers the mental image of a layout to be seen as it is when it comes in the field of vision. Intuitive thinking prefers to match the two images somehow and introduces biases which affect the decision making. This paper highlights the aspects, which can jeopardize safety during critical maneuvers. Simplistic solutions are suggested, which can enhance awareness and consciousness so that even in high workload situations, error is virtually eliminated.

Keywords: inattentional blindness, expectation, confirmation, fatigue, disorientation

## Inattentional blindness and bias during visual scans

The proverb, seeing is believing means that you need to see something to believe it; visible facts cannot be denied. This a general statement valid for most scenarios but human psychology warns us that this statement may not be true under certain set or combination of circumstances. Two aviation and one marine occurrence has brought up the question, “Why didn’t the crew see the obvious”? In any accident/incident there is no single root cause, there are a number of contributory causes. A detailed investigation will reveal the probable cause along with the contributory causes. All the accident/incident investigations that will be analyzed will have one thing in common, certain aspects of cognitive side of crew were not investigated from a human factor and psychological view.

1. Taxiway over flight Air Canada 759 at KSFO (called AC759) 07 July 2017,
2. Risk of collision Canadian North B737 flight no. MPE9131 and Jazz aviation DHC08 (called MPE9131) 04 Aug 2014,
3. Marine accident Greenville nuclear submarine and Ehime Maru fishing & Training trawler, 09 Feb 2001.

According to a 2007 Federal Aviation Administration report, there were 267 instances of pilots mistakenly landing on a taxiway parallel to a runway in the United States between 1962 and August 2007. These events, identified through U.S. National Transportation Safety Board and Aviation Safety Reporting System databases, occurred at 110 different airports and involved aircraft from the spectrum of operator types. There were multiple occurrences at 44 of the airports, with single occurrences at the remaining 66. It should be noted that these data included only aircraft that had landed on the taxiway; the number of instances of runway/taxiway confusion that were detected prior to landing was likely much higher (Transportation Safety Board of Canada, "Aviation Investigation Report A14W0127", 2015).

Investigation reports of the two incidents had a few commonalities. The captain was

the pilot flying and the first officer was the pilot monitoring (PM) and visual approach was being carried. Where there was a parallel runway, it was closed and notified as a notice to airmen (NOTAM). There were parallel taxiways too. The crew had flown to the airport frequently and were not new to the topography and procedures.

### **Expectation Bias**

The Purdue University carried out a study of accidents incidents of landing on wrong runways and wrong airports. One of the reasons for landing at the wrong surface is that flight crew have a mental picture of the airport and orientation of the runways, this is compared with what the pilot see outside. The pilots misjudge the time, speed, distance and; finally, misidentify the landing surface through distortion of facts of the facts of reality (Antuano & Mohler, 1989). The pilots are thus, disoriented and are inadequately informed by the external visual environment. This is more so when transiting from instrument conditions to visual conditions.

Visual cognition is limited by the number of computations it can perform, because the brain can process only a fraction of the visual faculties in detail, and by the inherent ambiguity of the information entering the visual system (Christopher, 2011). The brain prioritizes the information to reduce the burden. Attention prioritizes stimulus processing on the basis of motivational relevance, and expectations constrain visual interpretation on the basis of prior likelihood.

Expectation is the state of the brain that reflects prior information about what is possible or probable in the forthcoming sensory environment. Expectation leads to faster acquisition and interpretation of the visual input.

### **Confirmation bias**

Once the human has adopted an opinion either received or self-agreed, he draws all things else to support and agree with it. He then neglects or sets aside and rejects any input

even though it may outweigh the current opinion. And though there be a greater number and weight of instances to be found on the other side, yet these it both neglects and despises, or else by some distinction sets aside and rejects; in order that by this great and pernicious predetermination the authority of its former conclusions may remain inviolate Francis Bacon (1620/1939).

People tend to seek information that they consider supportive of favored hypotheses or existing beliefs and to interpret information in ways that are partial to those hypotheses or beliefs; conversely, they tend not to seek and perhaps even to avoid information that would be considered counter indicative with respect to those hypotheses or beliefs and supportive of alternative possibilities (Koriat, Lichtenstein, & Fischhoff, 1980).

### **Sleep deprivation/fatigue**

Evidence suggests that certain conditions such as fatigue, sleep deprivation and cognitive overload, predispose decision makers to using intuitive processes (Corskerry, 2012). More biased decision making resulting in more errors take place as an outcome of fatigue and sleep deprivation. At the end of a 16 hours of being awake, the cognitive power is reduced to 75% and the impact is in the cognitive function located in the pre-frontal cortex leading to degraded analytical reasoning and impaired monitoring. There is also an increased tolerance of risk and loss of situational awareness.

### **Inattentional blindness**

Everyone has some awareness of the limited capacity of attention, and our social behavior makes allowances for these limitations. Intense focusing on a task can make people effectively blind, even to stimuli that normally attract attention (Kahneman, 2011). When engaged in a demanding task, attention can act like a set of blinders, making it possible for salient unexpected stimuli to pass unnoticed right in front of our eyes (Neisser & Becklen, 1975). This phenomenon of “sustained inattentional blindness” is best known from Simons

and Chabris' (1999) study in which observers attend to a ball-passing game while a human in a gorilla suit wanders through the game. Despite having walked through the center of the scene, the gorilla is not reported by a substantial portion of the observers. Does inattention blindness (IB) still occur when the observers are experts, highly trained on the primary task? (Drew, Vö, & Wolfe, 2013) In computed tomography (CT) lung cancer screening, radiologists search a reconstructed 'stack' of axial slices of the lung for lung nodules that appear as small light circles. A series of experiment conducted with 24 radiologists (mean age: 48; range 28–70), they had up to three minutes to freely scroll through each of 5 lung CTs, searching for nodules as their eyes were tracked. Each case contained an average of 10 nodules and the observers were instructed to click nodule locations with the mouse. On the final trial, a gorilla with a white outline was inserted into the lung.

In the experiment, 20 of 24 expert radiologists failed to note a gorilla, the size of a matchbook, embedded in a stack of CT images of the lungs. This is a clear illustration that radiologists, though they are expert searchers, are not immune to the effects of IB, even when searching medical images within their domain of expertise. Potchen (2006) showed that radiologist could miss the absence of an entire bone. Why do radiologists sometimes fail to detect such large anomalies? Of course, as is critical in all IB demonstrations, the radiologists were not looking for this unexpected stimulus. Though detection of aberrant structures in the lung would be a standard component of the radiologist's task, our observers were not looking for gorillas. Presumably, they would have done much better had they been told to be prepared for such a target. Moreover, the observers were searching for small, light nodules.

### **Selection of landing surface**

#### **Air Canada AC759**

AC759 executed a visual approach to land on a taxiway followed by a go around. AC759 was cleared for the quiet bridge visual approach runway 28R on completion of the

standard terminal arrival route (STAR) (NTSB, "Accident Investigations", 2018). Runway 28L was closed as per NOTAM. The Captain had been awake for almost 16 hrs when he was flying the approach. The Captain had flown to this airport a number of times; thus, had a good mental picture of the airport with two closely spaced parallel runways. The flight crewmembers had recent experience flying into SFO at night: the captain reported that he had flown into SFO one or two times during the previous 4 months. The captain flew the STAR and at the final descent point transitioned from instrument to visual reference at the same time switched off automation. There was a lighted flashing "X" placed on the closed runway 28L but as per NTSB, the flashing rate was too slow to have been noticed by the crew. The crew would have first sighted the landing runway 28R in front since the approach lights were illuminated and then they would have seen the parallel taxiway dimly lit but with similar dimensions to that of the runway. The captain in his interview said that he knew that runway 28L was closed as per the NOTAM. Expectation bias would have set in when only one runway and associated approach, PAPI lights were sighted. The parallel taxiway was visible, and the lights of the parallel taxiway close to the runway, the pilot's mental picture of the two runways was incomplete, as he had expected. Humans use their intuitive decision-making 90% of the time and more so when they are tired. They resist the analytical part of decision making. The mental and real pictures didn't match; therefore, the pilot assumed that the now closed runway 28L was still open and the runway in front of him was runway 28L. Expectation bias lead to confirmation bias. As per this assumption he now believed that the lights right of the runway lights were those of runway 28R, which were in fact of the parallel taxiway 'C'. Despite all visual evidence pointing out that the taxiway did not have approach lights nor did it have a PAPI for vertical descent guidance, the pilot aligned the aircraft trajectory with the taxiway parallel to the runway.

The captain had aligned the aircraft with the parallel taxiway "C"; instead, of the

runway 28R despite all visual illuminations associated with an active runway visible. The taxiway dimensions were similar to the runway and there was a centerline light like what a runway has but green in color as against white runway centerline lights. With this assumption and decision, the mental picture matched what they saw in their field of vision ahead of them. Three aircraft were taxiing on the taxiway. These were large passenger jets, and they had their navigation lights steady, flashing beacon on top illuminated. The crew did not sight any of the three aircraft. The preceding aircraft that landed on runway 28R had sighted the runway number written when his aircraft was 300' above the runway. AC759 could not see any of the three large jet aircrafts at 300'. They did see some lights and queried the air traffic controller (ATC) to which the ATC checked runway 28R visually and on the radar scope for any aircraft and replied that the runway was clear.

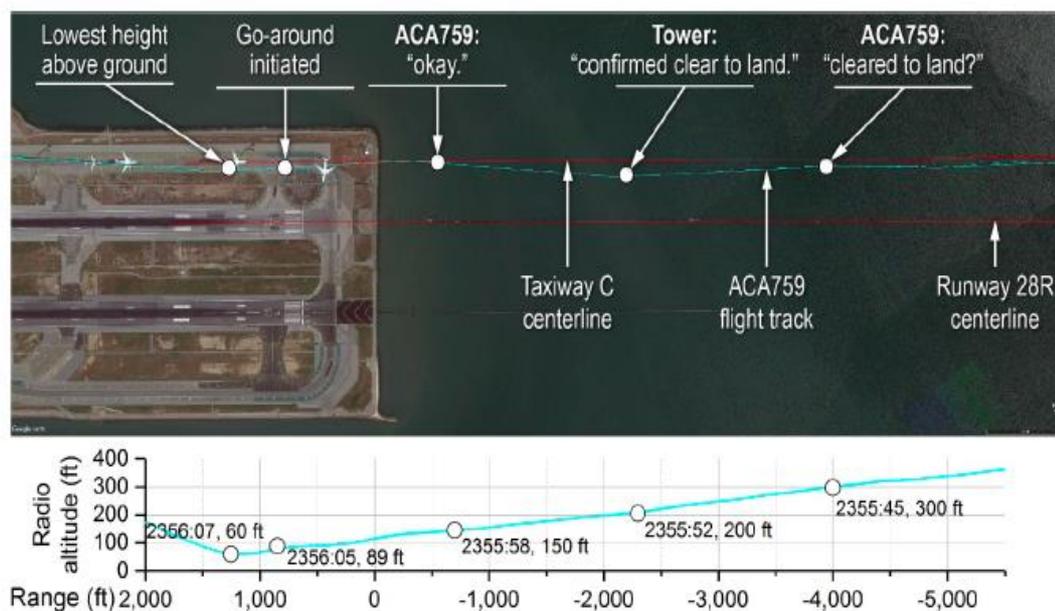


Figure 1 Flight profile of AC759 at KSFO

The reason crew did not sight the three large passenger jets can be attributed to inattentive blindness. A fatigued crew had aligned the aircraft with a taxiway due to expectation and confirmation bias. With limited cognitive capacity and analytical skills due to fatigue and biases, the crew further got a confirmation from the ATC that the runway was

clear. During approach to land, the pilot's attention was focused to keep the aircraft on the lateral and vertical profile i.e., maintain the centerline and aim for the touchdown point. They do not normally expect or look out for aircrafts on the runway since they assume that the ATC is controlling the access to the runway. Inattentional bias sets in when maximum attention is focused on a particular activity, here the crew were focused on the dimly lit taxiway and trying to fly a vertical profile with limited guidance that they were blinded to unexpected objects in their field of vision. It relates to the gorilla in the CT scan experiment, which could not be detected since the radiologists did not expect them to be there and were focused on looking for smaller sized images.

### **Canadian North B-737 MPE9131**

Canadian North B-737 flight number MPE9131 executed a visual approach to land on a taxiway followed by a go around. MPE9131 was preparing for the approach at Fort McMurray, Alberta, CYMM and obtained the weather through the ATIS (Transportation Safety Board of Canada, "Aviation Investigation Report A14W0127", 2015). Visibility was 4 statute mile (sm) and cloud ceiling 4100' for runway 25. The company SOP required an instrument approach when visibility is less than 5sm. The crew decided to carry out a visual approach but set the approach aids for an ILS approach for runway 25 and carried out an approach briefing accordingly. A regional jet, which landed before them asked the ATC for the reason for using runway 25 because they were landing into the sun and the smoke, was making it difficult to see the runway environment. MPE9131 was given step descent, instructed to reduce speed and to fly to a waypoint 12.8nm from the runway before turning back and cleared for ILS approach. When cleared for approach, the aircraft was established on the extended centerline for runway 25, but was higher than the required vertical profile and at the final approach fix by 2.5 dot. The aircraft had leveled out at the platform height.

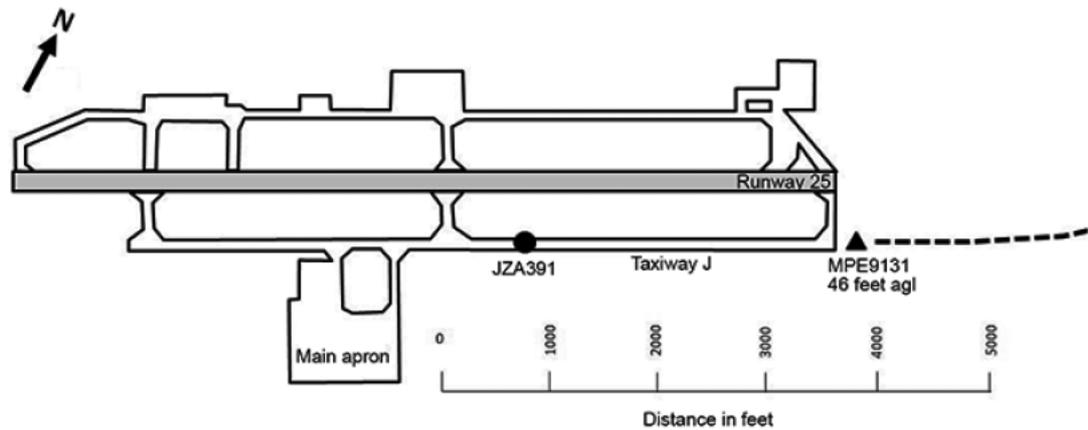


Figure 2 Flight profile of MPE9131 at CYMM

At this time a B737 was cleared to taxi via the parallel taxiway and to hold short of the landing runway 25. MPE9131 leveled out at 3000' (1800 AAL) and at 3.5nm to touchdown the captain disconnected the autopilot and auto thrust followed by a left turn and initiated descent. The pilot aligned the aircraft with the taxiway on the left and descended at a high rate. The glideslope alert was triggered since the aircraft was now below the vertical profile. The glide slope warning stopped when the aircraft was abeam the threshold but over the taxiway. The crew asked the ATC if the runway was clear and the ATC replied that it was. The aircraft descended below 50' aligned with the taxiway before the taxiing aircraft announced over the tower frequency that there was an aircraft lined up with the taxiway.

The airport has two parallel taxiways either side of the runway. While approaching runway 25, taxiway "J" is on the left of the runway and runs parallel from the start of the runway but half the width of the runway. Taxiway "G" is on the right side and is connected with the threshold via a taxiway at 45 degrees angle. The visibility had dropped from 4 sm to 2.5 sm when the approach was commenced but the pilots were unaware of it. The approach lights for runway 25 had not been switched ON. The pilots had completed almost 11 hrs of duty and would have been awake for almost 14-16 hrs. They were unaware of the visibility drop and the sun was in their eyes, making it even more difficult to locate the runway. With

approach lights OFF, both the surfaces would have looked similar. The taxiway 'J' had been commissioned 4 months before, and the crew had flown with the new taxiway open but had significantly more experience flying into the airport before opening of the taxiway.

The mental picture that the crew probably had was from the time they operated frequently, before the new taxiway opened. They would have expected a taxiway 'G' and the runway to the left of the taxiway 'G'. The taxiway 'J' is more prominent than 'G' since its positioning is squared to the runway whereas 'G' starts after the threshold linked by a taxiway at an angle of 45 degrees. The crew were carrying out visual approach in poor visibility for a visual approach, coupled by the setting sun and no approach lights. They were aligned with runway 25 but were high on approach and leveled out at 3000'. Since they were expecting the runway to be on the left of the taxiway, and the taxiway 'J' was more prominent than 'G', they would have decided that runway 25 was to the left and turned left at 4nm to touchdown and initiated descent at a high rate. These actions can be attributed to expectation and confirmation bias as explained in the beginning of the paper and seen in the Air Canada incident as well. The aircraft was high on profile at 4 nm to the runway and since the taxiway 'J' to which the crew had turned towards was half the width of the runway, the crew got the perception that they were even higher. They increased rate of descent and at 1000' AAL they were descending at 1200'pm. They disregarded the glide slope alerts when they crossed the glideslope signal and went below profile due to confirmation bias and reached 50' AAL before the beginning of the taxiway or abeam the runway. There was a Boeing 737 taxiing on the taxiway 'J' but the crew did not detect the medium sized commercial jet since their attention was towards getting back on profile for landing. This presence was unexpected, and they did notice something, asked ATC if the runway was clear and the ATC replied clear since there was no aircraft on the runway. Due to expectation and confirmation bias the crew were preoccupied in getting back on profile and aligning with the

landing surface, this was the probable cause of suffering from inattentive blindness.

An experiment was conducted using flight simulator and approaches flown under low visibility with the head up display. There was no need to scan the instruments since all the relevant information was available through the head up display. The result concluded that a few pilots did not see a large commercial jet on the runway and those who saw the aircraft were almost 2.5 times slower in executing a go around maneuver.

### **Greenville and Eham Maru**

The commander of the nuclear submarine USS Greenville near Hawaii, ordered a surprise maneuver known as “emergency deep” in which the submarine suddenly dives (NTSB, "Accident Report Detail", 2001). He followed this with an “emergency main ballast tank blow,” in which high pressure air forces water from the main ballasts, causing the submarine to surface as fast as it can. In this maneuver the bow of the submarine leaves the water surface and comes out of the water ("Marine accident brief", 2001). As the Greenville performed this maneuver, and the bow surfaced, the crew heard a loud noise, and the entire submarine shook. The submarine's bow had surfaced and torn through the fishing trawler. Within minutes, the trawler sank. Prior to initiating these maneuvers, the crew and the commanding officer had carried out a visual scan of the surroundings through the periscope. They did not see the huge fishing trawler. The crew and the commanding officer never expected the fishing trawler in the area where they were performing the maneuver; therefore, they probably did not see the ship.

### **Conclusion**

The incidents involved crew who were transitioning from instrument to visual approach. They had long flight duty periods and had enough experience flying to the airport. The probable cause for lateral alignment with the taxi way can be attributed to the mismatch between the mental picture based on past experiences, and the visual indications acquired.

Expecting the landing runway to be adjacent to a runway/ taxi way caused the expectation bias to take a decision for alignment to the incorrect landing surface. Due to limited cognitive capability at that stage, and probably due to intuitive decisions, the pilots aligned with the taxiway and ignored all obvious and coherent indications of sighting the runway. This indicates confirmation bias, and the crew continued to fly the approach with vertical assistance from internal or external guidance. The reason for not sighting the aircrafts on the taxiway was probably due to inattention blindness. This has been proven in the gorilla experiment where in one case the life size gorilla was unnoticed by many observers amongst the basketball players and in the other case expert radiologists could not detect a matchbox size gorilla figure in the CT scan film. This was due to increased focus on the primary task and not noticing the unexpected. The pilots would not have expected three aircrafts on the runway; therefore, they were not looking for them, instead they were focused on the landing surface and maintain the vertical profile at night/poor visibility in a black hole approach.

These are human cognitive limitations, which have been highlighted in other means of transport accidents. The crew needs to be aware of their limitations, especially when a task demands too much attention and/or when they are fatigued. Awareness of one's limitation, trusting the instruments and having adequate cross check with the crew and ATC can help to prevent the bias as described in the paper.

## References

- Accident Investigations. (2018, May 02). Retrieved from <https://www.nts.gov/investigations/Pages/DCA17IA148.aspx>
- Accident Report Detail. (n.d.). Retrieved from <https://www.nts.gov/investigations/AccidentReports/Pages/MAB0501.aspx>
- Neisser U, Bacon, F. (1939). *Novum organum*. In Burt, E. A. (Ed.), *The English philosophers from Bacon to Mill* (pp. 24-123). New York: Random House. (Original work published in 1620)
- Becklen R. *Selective looking: Attending to visually specified events*. *Cognitive Psychology*. 1975; 7:480–494.
- Brockmole, J. R., & Wang, R. F. (2002). *Switching between environmental representations in memory*. *Cognition*,83(3), 295-316. doi:10.1016/s0010-0277(02)00012-4
- Christopher, S. (2011). *Expectation and attention in visual cognition: Neural and computational approaches*. *Frontiers in Human Neuroscience*,5. doi:10.3389/conf.fnhum.2011.207.00036
- Croskerry P. *ED Cognition: any decision by anyone at any time*. ED administration series. CJEM In press 2012.
- Drew, T., Võ, M. L., & Wolfe, J. M. (2013). *The Invisible Gorilla Strikes Again*. *Psychological Science*,24(9), 1848-1853. doi:10.1177/0956797613479386
- Kahneman, D. (2013). *Thinking, fast and slow*. London: Penguin. p 31-38
- Koriat, A., Lichtenstein, S., & Fischhoff, B. (1980). *Reasons for confidence*. *Journal of Experimental Psychology: Human Learning and Memory*, 6, 107-118.
- Simons DJ, Chabris CF. *Gorillas in our midst: sustained inattention blindness for dynamic events*. *Perception*. 1999; 28(9):1059–1074. [PubMed: 10694957]

Transportation Safety Board of Canada. (2015, November 04). Aviation Investigation Report A14W0127. Retrieved from <http://bst-tsb.gc.ca/ENG/rapports/reports/aviation/2014/a14w0127/a14w0127.asp>