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Aircraft Accidents Aren't — Part Two

In this second of a two-part series, the author focuses on the causative chain of events of a typical risk-denial-induced accident and presents a preventive process.

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Part one described a risk denial syndrome, "it won't matter," that allows the buildup of seemingly trivial events that collectively can create sufficient elements of risk to cause accidents. In the first of this two-part series, the author described the syndrome and illustrated it with an example accident, the crash into the Florida Everglades of a Lockheed L-1011 while the flight crew was dealing with an inoperative landing gear indicator light bulb. Part two analyzes the chain of preventable events and suggests a curative approach.

The author stated at the end of Part One that if any one of 15 independent events had not occurred, the accident would have been prevented. The 15 events or errors will be classified in Part Two of this series under five types of anomalies.

Operational Procedures

Event No. 1: At 2337, the captain (Capt) asked the first officer (FO) to remove the light fixture. Until then, the FO had been monitoring the flight path of the airplane and the performance of the autopilot. The Capt implied that the FO should then devote his attention to the light fixture. The FO incorrectly assumed that the Capt would take over the command of the autopilot and control the flight path of the airplane. From this point on, both pilots were devoting their attention to the light bulb problem. Neither pilot was devoting the required attention to the performance of the airplane.

Event No. 2: This occurred at 2341:40 when the approach controller expressed his concern over the radarscope indication of Eastern 401's altitude — at that time, the aircraft was at 900 feet and descending. He transmitted, "Eastern, ah, 401, how are things coming along out there?" The Eastern pilots assumed that the controller wanted to know about the nose gear light bulb problems. They were unaware of the fact that the controller was concerned about their altitude. Any mention of altitude deviation would have alerted either pilot that their altitude was dangerously low but still adequate for a recovery.

Training Inadequacies

Event No. 3: The flight crew had not been trained or experienced in removal and replacement of the landing gear indicator fixtures. If they had been aware of the ease with which the fixture could be incorrectly installed, they would have taken pains to insure its proper reinstallation.

Event No. 4: The autopilot configuration used novel and unique control wheel steering modes. The pilots had not been trained to proficiency on several of these modes. As the captain leaned forward and reached across the throttle quadrant to change the light bulb fixtures, his chest pressed on the control column. There was just enough force to shift the autopilot from the command mode to the control wheel steering mode. This allowed the autopilot to command a nose-down movement of the airplane, undetected by the pilots. The pilots were not sufficiently familiar with the operational modes of the autopilot. More thorough training would have made them aware of the ease with which the autopilot would shift modes when the control column was moved. They should have been aware of the possibility that further pressure on the control wheel would cause more nose-down pitching movements with resulting rapid descents.

Event No. 5: The flight crew's unfamiliarity with the nose gear viewing port in the lower electronic equipment bay consumed several extra minutes. None of the fight crew had ever viewed the nose gear through the viewing port. The maintenance supervisor was the only person in the cockpit who had experience with using the viewing port.

Event No. 6: The weather was bright and clear, with excellent visibility of more than 30 miles in the Miami area. This led the crew into a false sense of confidence and complacency. In general, there are correlations between margins of safety and visibility. On a dark and stormy night, the crew would have been much more wary and alert to the need for aircraft flight path monitoring.

Event No. 7: The aircraft was flying over the "black hole" of the Everglades — no surface lights were present to form a ground pattern and establish a ground plane. The lights of Miami, more than 10 miles distant to the left, provided a very subtle indication that everything was all right. Any type or number of ground pattern lights, even those found over rural farmland areas, would have been helpful. The pilots, through their peripheral vision, would have detected that the airplane was descending rapidly.

Design Factors

Event No. 8: The nose gear light fixture did not have a shadow divider between the two light bulbs. The usual practice is to put a shadow divider between the light bulbs to enable the pilots to see that one-half of the light fixture is dark when the first light bulb fails. The second light bulb, while working, confirms to the crew that the safety indication is present. Thus, the failed light bulb can be immediately identified. For Flight 401, the L-1011 could have been flying for several days with one undetected failed light bulb in the nose gear fixture. The second light bulb failed between JFK and Miami, resulting in the highly improbable situation in which both light bulbs were inoperative at the same time.

Event No. 9: When removed from its receptacle, the nose warning gear light fixture did not incorporate a clear and positive indication of the correct orientation for reinsertion. The glass plate covering the fixture had the word "Nose" inscribed on the inside. It could only be read when illuminated. With the almost square fixture removed and no light shining through the inscription, it was very difficult to tell which way was up. If the inscription had been on the exterior of the glass plate, the correct orientation for reinstallation of the fixture would have been obvious immediately.

Event No. 10: The nose gear warning light fixture was almost square, but not quite. It was possible to reinsert it incorrectly and jam the fixture so it could neither be put in nor pulled back out again. A fixture with a very definite keyed slot or abnormal shape would have required correct alignment to even begin to install it.

Event No. 11: The autopilot mode annunciator light gave only a very subtle indication of autopilot mode shifts. Adjacent lights of the same size, color, and intensity were used to show the mode status. When the shift occurred, one light blinked off and the other light blinked on instantaneously. Unless the pilots were looking directly at the lights, they would hardly detect the shift. A signal that attracts the pilot's involuntary attention when the modes are shifted might have prevented this accident.

Event No. 12: The altitude-alerting device did not get the involuntary attention of the crew. This device sounded when the airplane had deviated 300 feet from its command altitude. Even though it was possible to hear it, the sound was subtle. The pilots, under the stress conditions they were in, were not aware that the alerting signal had sounded. A higher intensity, longer duration or a bizarre sounding signal would have alerted the pilots to the altitude deviation and might have prevented the accident. In addition, the ground proximity warning mode of the altitude alerting device did not sound until two seconds before impact. If the signal had been made a few hundred feet higher, the crew might have been able to avoid the crash.

Event No. 13: The on/off switch for the nose well light was located in the cockpit instead of next to the nose well viewing port. The aircraft descended for several valuable minutes before crew members located the switch to get the nose gear illuminated for the visual down-and-locked check.

Event. 14: The breakout forces required to shift the autopilot from command to control wheel steering were light. With higher break-out forces, the pilots might not have inadvertently disconnected the command altitude hold mode of the autopilot. This disconnection allowed the airplane to shift to the control wheel steering mode and then descend rapidly.

Event No. 15: The only equipment failure on this new airplane was that both bulbs in the nose gear down-and-locked fixture were inoperative. if either of these bulbs had been working, there would not have been an accident involving Eastern Flight 401 that night.

"It Won't Matter"

The insidious nature of these types of scenarios is that any single "it won't matter" decision usually is benign the first, second, or even several times they occur. When the disregard is perpetuated for weeks, months, or years, the probability increases markedly that the error will intersect or link up with another independent event also defined as benign. The pathogen theory of Reason (1987) is then in place. Predicting human error is very similar to predicting earthquakes. We can predict if an error is likely to occur with a fair amount of certainty. We cannot predict exactly when it will occur. We can identify the conditions, or pathogens, that are conducive to pilot error (Besco, 1988). As in predicting earthquakes, we cannot predict the precise time the breaking point will be reached. We do know the conditions that promote errors. When these conditions are present, errors will occur. It is a question of when they will occur. It is not a question of if they will occur. It is similar to the old saying about the last straw that broke the camel's back. The "it won't matter" philosophy eventually *will* matter.

The probability of an accident resulting from one hazardous process of event is extremely low. Accidents do result from a sequential chain of events and a pathogenic climate of complacency and neglect. Any one event in a chain that did not occur would break the chain or sequence and prevent the accident. Each negative event by itself could have easily been prevented or removed.

Qualified, responsible professionals have regarded these events as being trivial, benign and inconsequential. Potentially lethal anomalies are sometimes judged as being unworthy of the effort to have them changed. It has taken a thorough investigation of aircraft accidents to identify all of the innocuous errors and bring them to light. The significance of these "minor" events is only realized after an accident. Psychologists need to study the risk perception and risk denial syndromes in aviation to establish the basic parameters of the risk awareness process. Every one in aviation from the flight line to the board room needs to be sensitized to risk. Wariness is the term Bruggink (1975) has given to risk sensitivity and risk awareness. Behavioral scientists can contribute to a better understanding of these processes.

Psychology can offer much assistance to programs of human performance improvement in aviation. Non-psychologists Bruggink and Lederer have been advocating for decades that the key to improved aviation safety and performance lies in the improved performance of executives as well pilots. To depend on aptitude testing and training improvements as the primary vehicle for change is appealing to both psychologists and airline managements. Regardless of the validity of the selection program, the organizational climate must be free of performance degrading pathogens. No matter how effective the training is, performance will suffer if the organization exhibits unsanitary attitudes towards its human resources. Too often, training is viewed as the panacea to which we turn when performance needs to be improved. Training must be totally integrated with the operational and organizational environment (Andrew, 1951, Bennis and Nanus, 1985 and Besco 1989a). A training program is sometimes viewed as a laundering process that will wash out all the dirt that is present. It is analogous to insisting that a child has clean clothing before being sent out to play in the mud.

Total Systems Approach

Psychology must take a total systems approach to the problem of improving performance in aviation. Psychologists can improve attitudes, increase knowledge and sharpen skills with their time tested tools in selection, training and industrial/organizational development. Human factors engineering can contribute greatly to enhancing the system performance with improved designs and configurations. Physiological psychology can aid the aviation medical profession in upgrading health maintenance programs and reducing environmental stresses. Personality and social dynamics psychologists can contribute to development of better teamwork.

Psychologists have been perceived by aviation managements as taking a narrow, biased and parochial view of human performance. Individual psychologists have tended to oversell the value of their specific disciplines to resolve nearly any problem. Singularly trained human engineers, learning psychologists, aptitude testers, social psychologists or personality theorists have but a minor role to play. They need to apply the integrated disciplines of all behavioral sciences. Multi-disciplinary psychologists or teams of psychologists will have a major role in "making the world a better place in which to fly."

Conclusions and Recommendations

Quite often accidents are blamed on the event that occurs most proximal in time or place to the accident site. It is an old axiom that the pilot is the first to arrive at the scene of an accident. It has become very easy to hold the flight crew responsible and to ignore more subtle but just as powerful influences on the error chain. If a particular crew mistake had not occurred, the accident would have been prevented. To limit our attention to these "proximal" causes will drastically reduce the probability of managing the other risks. A process that identifies all the events or mistakes in the chain leading to the accident is needed for maximum effectiveness. Commercial aircraft catastrophes are usually not caused by one or two major blunders. In most air crashes, at least a dozen independent, low probability, seemingly benign events occur in highly improbable sequences to bring about the accident. Removing the occurrence or changing the order of any one of these events or mistakes might prevent an accident. Therefore, it is crucial to very carefully identify all of these potential negative events.

What is needed is a risk identification, risk awareness and risk management program that identifies and defines all of the seemingly trivial risks before they cause an accident. The safety program must doggedly pursue risks to eliminate them from the system (Bruggink, 1975). Once identified, most risks are relatively simple and inexpensive to remove or to reduce to practically zero. Risks are allowed to remain not because of the difficulty of removing them; they persist in the system primarily because the consequences of their independent existence are judged to be of an significant or benign nature. All professionals in aviation, from pilots and mechanics to directors on corporate boards, need to be dedicated to the removal of risks and pathogenic conditions which induce error. By removing all such small independent risks, we can prevent them from accumulating to cause major catastrophes. Neither heroic discoveries, nor dramatic bold actions, nor major changes in the system will be the most effective vehicles for significantly reducing unnecessary risks. Multi-disciplinary psychologists can assist in "making the world a better place which to fly" by paying meticulous attention to and developing in all participants a persistent distaste for all of the seemingly mundane elements of risk. ♦

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