# AN ASSESSMENT OF PREDOMINANT CAUSAL FACTORS OF PILOT DEVIATIONS THAT CONTRIBUTE TO RUNWAY INCURSIONS

by

Denado M. Campbell

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Thesis Committee:

Dr. Wendy S. Beckman, Chair

Dr. Paul A. Craig, Committee Member

Dr. Ronald J. Ferrara, Chair, Aerospace Department

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## ABSTRACT

The aim of this study was to identify predominant causal factors of pilot deviations in runway incursions over a two-year period. Runway incursion reports were obtained from NASA's Aviation Safety Reporting System (ASRS), and a qualitative method was used by classifying and coding each report to a specific causal factor(s). The causal factors that were used were substantiated by research from the Aircraft Owner's and Pilot's Association that found that these causal factors were the most common in runway incursion incidents and accidents. An additional causal factor was also utilized to determine the significance of pilot training in relation to runway incursions. From the reports examined, it was found that miscommunication and situational awareness have the greatest impact on pilots and are most often the major causes of runway incursions. This data can be used to assist airports, airlines, and the FAA to understand trends in pilot deviations, and to find solutions for specific problem areas in runway incursion incidents.

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# CHAPTER I: Introduction

For years, runway safety has been a major concern for the Federal Aviation Administration (FAA) and the National Transportation Safety Board (NTSB). In fact, the NTSB identified runway incursions as a significant topic of study for safety in the United States of America in 2012, placing it on the Most Wanted List of safety improvements for that year. Runway safety remained an issue of concern the following year although it was not listed on the Most Wanted List explicitly. Instead, the NTSB categorized it under a new topic on the Most Wanted List for 2013 as "Improve Safety of Airport Surface Operations." Although a lot broader topic, the NTSB still outlined runway incursions and excursions in this edition as an interested area of study. Airports in the United States are still fighting to remain both efficient and safe, yet are faced with the occasional runway incursion or excursion. The FAA defines a runway incursion as "any occurrence at an aerodrome involving the incorrect presence of an aircraft, vehicle, or person on the protected area of a surface designated for the landing and takeoff of aircraft" (Federal Aviation Administration [FAA], 2008).

## Review of Literature

A collision of two airplanes in the sky cries chaos, tragedy and death. However, the same is true for airplane collisions on the ground. Since 1973, the NTSB has been making recommendations to the FAA with regard to runway incursions (National Transportation Safety Board [NTSB], 2000). This fact dates this major area of concern back to at lest that date. Since then, the NTSB has issued special investigation reports on runway incursions and has listed runway incursions on the Most Wanted List from the year 1990 until the year 2012 (NTSB, 2000). On March 31, 1985 the aviation industry

was faced with a near collision of two aircraft on an active runway. The near collision involved two Northwest Airlines DC-10 aircraft at the Minneapolis-St. Paul International Airport. One of the aircraft was cleared to take off by air traffic control. The other aircraft was cleared by ground control to taxi across the same runway. Seconds into the takeoff roll, the captain of the departing aircraft noticed the other on the runway and made a quick decision to takeoff below the required takeoff speed. While this method was risky, it saved nearly 500 passengers and crew from being engulfed in flames. The approximate distance between both aircraft was between 50 feet and 75 feet (Diane Publishing, 2000). Had this collision occurred, it would have been known as one of the deadliest aviation accidents to have ever happened.

In fact, the deadliest aviation accident to date was also a runway incursion, where the victims were not so lucky as those in the near collision at Minneapolis-St. Paul International Airport. On the afternoon of March 27, 1977, there was congestion and an overflow of aircraft at Los Rodeos (Tenerife) airport on Tenerife Island. This was due to a terrorist bomb explosion that occurred at the Las Palmas, Canary Islands airport. Involved in the congestion at the Tenerife airport were two Boeing 747 aircraft, one of the largest aircraft of the time for passenger transport. One was a KLM Airlines aircraft, the other a Pan American Airlines aircraft. Both aircraft were located on the taxiway at the approach end of runway 12. Once the Las Palmas airport reopened, they both had to taxi to the opposite end of the runway to takeoff. Unfortunately, the single taxiway was filled with other aircraft at the time. The air traffic controller instructed both aircraft to back taxi down the runway in order to reach the approach end of runway 30. The first to receive clearance onto the runway was the KLM pilot who was instructed to taxi all the

way to the end of the runway and then make a 180-degree turn, line up, and wait for takeoff clearance. While the KLM aircraft was taxiing, air traffic control gave the Pan American aircraft permission to enter the runway, taxi to the third taxiway, then exit. There was confusion in the cockpit as to the controller's instructions as well as regarding the taxiway on which to exit. During the time of taxi, a thick fog had overtaken the area and visibility had decreased. The controller also noted that the runway centerline lights were out. Meanwhile, the KLM aircraft had arrived at the approach end of runway 30 and the captain turned around and began his takeoff roll before receiving takeoff clearance from air traffic control. While the first officer and flight engineer realized this, the captain continued down the runway and the KLM aircraft collided with the Pan American aircraft just 13 seconds later (FAA, n.d.). On this day in history, approximately 583 lives were lost, making it the worst disaster in aviation accident history prior to September 11, 2001 (Clarke, 2002). This was also one of the first runway incursions that sparked public attention and a call for action by many regulating bodies.

After the disaster of the collision at Tenerife and the near collision at Minneapolis-St. Paul, the NTSB responded with its first runway incursion safety study in 1986 (Wells, 2001). Since this time, the NTSB continued marking runway incursions as a serious matter for concern and immediate correction. According to them, the FAA was not moving swiftly enough with their recommendations nor were they being firm about the corrective measures. The NTSB listed seven "most wanted" corrective measures for runway incursions, that included:

1. Visibility from the control tower
2. Airport signs and markings

3. Airports operating in low-visibility conditions
4. Complex runway intersections
5. Special highly reflective paint for surface markings
6. Runway edge lights
7. Radars and related systems to alert controllers of pending runway incursions (Diane Publishing, 2000)

From this study and the concurrent most wanted list, the FAA made several changes respectively:

1. The FAA completed a study of all control towers to determine the line of sight and visibility from the tower to the runway (Wells, 2001). After the study was completed, the FAA found that restrictions to visibility were present at 26 facilities. Most facilities were corrected with additional lighting, realignments, adjustments, and glare shielding (Diane Publishing, 2000).
2. For signs and markings at airports, the FAA released an advisory circular (as approved via the NTSB recommendations) for airports to follow when implementing signage to reduce pilot-induced incursions. A proposed deadline of January 1994 was established for all certificated airports to comply with the installation of new sign systems (Diane Publishing, 2000).
3. With regard to airports operating in low visibility conditions, the FAA issued an advisory circular for airports to use as guidance if they chose to operate landings in low visibility or with a runway visual range of less than 1,200ft. As stipulated within the advisory circular, airports wishing to operate under such conditions are

required to install visual aids such as runway guard lights (Diane Publishing, 2000).

4. In order to locate airports with complex intersections, the FAA organized a team of industry leaders that included: airport owners, airline representatives, air traffic controllers, flight standards personnel, and pilots. These teams were known as Runway Incursion Action Teams (RIATs) and were located in each regional office. Their main objective was to locate complex intersections that possibly led to confusion by pilots. Their findings brought to light 51 airports with complex intersections that the FAA has since issued recommendations regarding, to reduce the number of runway incursions (Diane Publishing, 2000).
5. In order to examine the materials and techniques for durability of paint, a research team was organized and a subsequent advisory circular issued on the matter. It was advised that special highly reflective beads be used in paint to make markings a lot more conspicuous. At the time reflectorized paint was not mandatory but recommended for airport officials to use. However, if federal funds were to be used, glass beads in paint were mandatory (Diane Publishing, 2000).
6. In response to runway edge lights, the FAA instructed all of its Part 139 airport inspectors to conduct a complete examination on lighting that could possibly interfere with safety. Inspectors found 424 spots that were potentially dangerous at 72 airports. The FAA then informed airport operators that the lights did not have to be immediately installed, rather they should be installed when a major electrical upgrade was completed or when a reconstruction project commenced (Diane Publishing, 2000).

7. The FAA also developed special radar systems for controllers to detect when a runway is active and when it is not. This special ground mapping radar is known as Airport Surface Detection Equipment (ASDE). The installation of these has been rather slow as these started prior to these recommendations in 1971 and are still being installed at airports across the country (Diane Publishing, 2000).

Apart from these responses to NTSB recommendation, the FAA also changed the form of communication between pilots and controllers. Controllers are now required to obtain read backs from pilots, particularly at hold short lines, which was not required prior to the 1990's (Wells, 2001). Many of these changes were categorized into two categories: low and high technology. The low category initiatives were: land and hold short warning systems, an advisory circular on surface movement guidance control systems, airport diagrams for pilots and drivers, and requiring read backs from pilots to controllers. The high technology initiatives identified were: airport surface detection equipment (ASDE), runway status lights, airport movement area safety system, and airport traffic automation (Harrison, 1993).

Despite all the ordinances issued and changes made, the number of runway incursions each year still continued to creep up. During a round table discussion between both the Federal Aviation Administration and the National Transportation Safety Board in 1997, it was found that runway incursions had continued to increase from 1993 (Wells, 2001). To be more specific, in 1993 the total number of incursions reported was 186 and in 2001 the number rose to 431. This was an increase of 132% (Jones, 2002). While this reflects negatively on the industry, it is fair to note that the amount of air traffic increased during this time as well. The Bureau of Transportation Statistics (2015) notes that in 1996

total traffic volume, including passenger and cargo domestic flights, was 593,828 flights. In 2001, this number increased to 688,708 flights. This reflects a total increase of 16%. Eight years later, in 2004, the total number of flights reported by the BTS was 841,604 flights. This was an even greater increase of 42%. These numbers show that an increase in air traffic could be the cause of the increase in runway incursions. However, as noted, the increase in incursions has far exceeded that of the air traffic volume.

Since 2001, the total number of runway incursions has continued to increase each year. According to the FAA (2014), in fiscal year 2012, the total number of incursions was 1150, while in fiscal year 2013 the total increased to 1241, a total percentage increase of 8%. To take further account of runway incursions, fiscal year 2014 reported a total number of 1264 incursions. Although fiscal year 2014 showed an increase in incursions, the percentage increase showed a significant decline from that of previous years, to 2%. Again, it is important to note the air traffic volume in relation to the incursions that happened in these years as well. From fiscal year 2012 to fiscal year 2013, total air traffic volume increased from 728,537 flights to 731,952 flights. This is total of 3,415 more flights and an increase of 0.47%. The 2014 fiscal year had an air traffic total of 716,867 flights while the 2013 fiscal year had a total of 731,952 flights, a decrease of -2% (BTS, 2015). The decrease in flights is extremely significant and probably the reason for the decline in the runway incursion percentage. The FAA has noted that runway incursions have shown this decline, but have failed to mention that there has been an even greater decline in air traffic volume.

Recently, the FAA has established goals to meet each year and a runway safety plan to follow every two years. The FAA categorizes runway incursions based on

severity. Their model ranges from A to D, where D is the least severe and A is the most severe. “Category A is an incident in which a collision is narrowly avoided. Category B is an incident in which separation decreases and there is a significant potential for collision, which may result in a time-critical corrective/evasive response to avoid a collision. Category C is an incident characterized by ample time and/ or distance to avoid a collision. Category D is an incident that meets the definition of runway incursion, such as incorrect presence of a single vehicle/person/aircraft on the protected area of a surface designated for the landing and take off of aircraft, but with no immediate safety consequences,” (FAA, 2012, p. 5). In FY 2012 and FY 2013 the FAA had planned to reduce incursions in categories A & B by a rate of 0.395 per million operations (FAA, 2012). However, runway incursions increased from a total of 954 to 1,150 between the years 2011 and 2012 (FAA, 2012).

Several ideas to address the cause of runway incursions have been proposed. One in particular is developing a more effective communication regime between controllers and pilots/drivers on the ramp. A communication gap exists between controllers and pilots and controllers and ground vehicle operators. Probable causes that are associated with ineffective communication and have been identified are the use of non-standard phraseology, pilot stress during critical flight periods, and an overload of tasks on the controller who inadvertently agrees to an incorrect pilot read-back due to frequency overload (Singh & Meier, 2004). This Singh and Meier study further indicates that typically in pilot deviations, pilots miss portions of taxi instructions, take an incorrect turn due to disorientation, or do not stop at designated hold bars.

The Aircraft Owners and Pilots Association (AOPA) have also come up with several situations that influence the occurrence of runway incursions. The first is inadequate preparation, which leads to many mistakes. Because of this, pilots can become disoriented and find themselves taxiing onto taxiways and runways that they have not been cleared for. The second is focusing on the tasks at hand. It is easy to become distracted especially prior to departure, with flight instrument settings and flight computers. This lack of focus can lead to taxiing onto runways and crossing hold short lines without permission and taking off without clearance. A third cause is situational awareness. Pilots often fall victim to this when they are not aware of events surrounding their flight and their movement on the airfield. A lack of situational awareness can happen when pilots are not observant of radio frequencies and they miss ATC errors that lead them to a potential collision with other aircraft. A lack of situational awareness can also result in mistaking taxiways for runways. One final situation that contributes to runway incursions is poor communication. This often results in taking off without authorization to do so, and following instructions not intended for that aircraft (Aircraft Owners and Pilot's Association [AOPA], n.d.).

Other causal factors that have been identified that contribute to runway incursions are failure to comply with air traffic control instructions, lack of airport familiarity, and deviation from standard operating procedures. Pilots and drivers often fail to comply with ATC instructions because of poor communication or radio frequencies. It is important to read back all instructions verbatim, in particular hold short clearances to avoid crossing onto an active runway. Pilots also very commonly fly into unknown or new airports. This can sometimes be a challenge particularly at night or during times of low visibility. In

this instance, pilots should ensure they have current airport diagrams, pay close attention to ATC instructions, eliminate unnecessary talk and keep the cockpit sterile, be vigilant during taxi, and complete checklists only when the aircraft is stopped. Runway confusion can also play a role when unfamiliar with an airport. This is normally a result of airport complexity, close proximity of runway thresholds, and joint use of a runway as a taxiway (FAA, 2008).

Currently, there are a host of new technologies proposed to diminish runway incursions. These include the improvement and expansion of Airport Surface Detection Equipment, Electronic Flight Bags, and Final Approach Runway Occupancy (FAA, 2011). Broderick (2008) claims that the FAA was not using all of its resources to adequately tackle the runway incursion issue. With the proposed idea of modernizing the National Airspace System using Automatic Dependent Surveillance Broadcast (ADS-B) by providing basic information using NextGen technology, he claims the FAA should also mandate other services in this technology, including detection capabilities that transmit back to the aircraft and pilots. This would in effect improve runway safety. The FAA has since responded by evaluating this technology, along with equipping airport vehicles with transponders and installing moving maps in both aircraft and airport vehicles. In addition, the FAA has also realized that the Next Generation technology will play a huge role in improving runway safety by increasing situational awareness, accuracy, and communication between controllers and pilots (FAA, 2011).

One area of the NextGen technology that the FAA has started using in improving runway safety is Airport Surface Detection Equipment (ASDE). This technological infrastructure will provide pilots and drivers with better situational awareness as sensors

are placed in key locations at airports that determine and report aircraft or ground vehicle positions on the airfield (FAA, 2011). One way this system will work is in conjunction with enhanced Final Approach Runway Occupancy Signals (eFAROS), where ASDE technology will act as a surveillance-monitoring device that transmits the data to the eFAROS. Once it is detected by the eFAROS, the system will process it and detect possible conflicts between arriving aircraft and other traffic near runways. This system also works in conjunction with the PAPI that will serve as a direct visual aid for pilots to know when there is a possible incursion upon landing and therefore indicate the need to go around. This is done by the PAPI flashing as opposed to remaining steady (FAA, 2012).

In another use of the NextGen technology and ASDE, the FAA has employed Low Cost Ground Surveillance systems at a few airports around the country. These systems provide air traffic control with surface movement information on a display screen during low-visibility conditions (FAA, 2012).

Electronic Flight bags are another possible advancement to improve runway safety. While many of the other technologies have been ground based, these will be installed inside the aircraft to provide the pilot with a clear depiction of where they are on the airfield. This would be most crucial during nighttime operations or conditions of low-visibility when markings and signs are much harder to identify and the airport is unfamiliar (FAA, 2012).

Still another technology is the Runway status light system (RWSL) that has been installed at a few airports in the United States. According to the FAA (2014), there are currently nine airports that have fully functional RWSL and eight more are expected to

have these installed by the year 2017. These are compatible with Runway Entrance Lights (REL) and Takeoff Hold Lights (THL), which are all purely advisory, but aid in advising pilots or vehicle drivers not to enter or cross into a runway safety area. Runway Entrance Lights are placed on a taxiway that adjoins a runway to caution a pilot if it unsafe to enter the runway. Taxiway Hold Lights are placed on the departure end of a runway to notify a pilot that has taxied on the runway that it is unsafe to commence departure roll.

With so many new technologies being developed, it is hard to understand why runway incursions into FY 2015 have not improved. In an effort to further understand the problem, the FAA has also instituted many reporting systems to gather data on runway incursions. As previously mentioned, in former years, they have categorized runway incursions into three distinct types that help point to sources of errors:

- **Operational Incidents** – resultant factor directly caused by action or inaction of air traffic control
- **Pilot Deviations** – resultant factor directly caused by action or inaction of a pilot who violates any Federal Aviation Regulation
- **Vehicle/Pedestrian Deviation** – resultant factor directly caused by action or inaction of a non-pilot driver who has entered the runway safety area or airport movement area without permission of air traffic control or a pedestrian who has entered the runway safety area or airport movement area without authorization from air traffic control (FAA, 2012).

Statistically, pilot deviations have always been the most critical type of runway incursion. In a study conducted on runway incursions in the year 2000, it was found that

60% of all runway incursions were due to pilot deviations, vehicle/pedestrian deviations accounted for 20% of all incursions, and operational incidents were 20% of all runway incursions (Singh & Meier, 2004). In general aviation, pilot deviations accounted for 72% of all runway incursions (FAA, 2000). This marks general aviation operators as the highest for pilot deviations in runway incursions. In the year 2001, this number increased to 77% for general aviation pilots (Singh & Meier, 2004). In 2009, the Federal Aviation Administration reported that 63% of all runway incursions were attributed to pilot deviations (FAA, 2012). Thus, there is a need to identify the predominant cause for these runway incursions.

This research attempts to identify the major factors that compromise runway safety, in particular runway incursions, which remain a major challenge for airports and airlines alike. As explained above, the FAA categorizes runway incursions into three groups: Operational Incidents (action of the controller), Pilot Deviations (action of the pilot), and Vehicle/Pedestrian Deviations (unauthorized vehicles or pedestrians entering any part of the runway). Pilots, along with air traffic controllers, ground crew, and airport operations all play a vital role in the safety of each flight. However, it has been found that pilot deviations contribute to the majority of runway incursions. Thus, it is important to discover exactly where the problem exists, to find and fund possible solutions. Given the categories identified by the FAA, this study will use data on runway incursions retrieved from the National Aeronautic and Space Administration Aviation Safety Reporting System to determine why pilots remain the predominant cause for runway incursions. If this can be done, efforts can be focused on correcting these issues to reduce

pilot deviations in runway incursions. This study will focus on answering the following questions:

- What are the predominant causal factors that have contributed to pilot deviations leading to runway incursions that are recorded in NASA's Aviation Safety Reporting System database in fiscal year 2013 and 2014?
- What are the significant changes in these identified factors from fiscal year 2013 to 2014?

## CHAPTER II: Methodology

To attempt to understand the reason for the high number of pilot deviations in runway incursion incidents, a preliminary study was done by retrieving data from the FAA's Runway Safety Office Runway Incursion Database (RWS). The data retrieved did not conclude specific reasons as to why pilots made certain errors. Instead, just a short analysis of each incident was given. Data was then reviewed from NASA's Aviation Safety Reporting System (ASRS). Unfortunately, the data found here did not categorize the events into the categories like the RWS did; however, the data did provide a full account from each party involved in the event, the factors that played a role in the event, and a synopsis of the event. After reading through the runway incursion reports, several reoccurring anomalies presented themselves.

This research utilized a qualitative study as an attempt to gain an understanding of the underlying issue causing these pilot deviations. In addition, it attempted to discover potential trends in the problem of pilot deviations in order to find a corrective measure. The data analysis techniques that were used were classification and coding.

### Instruments

The instruments utilized in this study was data retrieved from reports gathered by NASA from their Aviation Safety Reporting database. The data retrieved was from fiscal years 2013 and 2014. The fiscal year for the FAA begins on October 1 and ends on September 30. The last year the NTSB listed Runway Incursions as a significant topic of research was 2012. To understand the trend after this fiscal year, the data from 2013 was retrieved. In addition, in 2009 the FAA started their Runway Safety Plan. As a result, FY 2013 and FY 2014 were chosen to provide insight on how efforts may have improved or

decreased the runway incursion since 2009. Moreover, 2013 and 2014 are the two most recently completed fiscal years for the FAA. In a comparison between both years, it was noted that there was a decrease in pilot deviations from fiscal year 2013 to fiscal year 2014.

On the ASRS database, NASA provides users with a wide array of search criteria on the search engine. These include: date of incident, report number, environmental conditions present during an incident, federal regulation associated with the incident, the type of flight plan filed, the phase of flight incident occurred, type of aircraft, type of operation, location of incident, who reported the incident and his/her position, the event type, the detector of the incident, the problem that caused the incident, any contributing factors associated and the consequence of the incident. From these, there were two criteria selected to retrieve the necessary data for this study – Date of Incident and Event Type. Once the date criterion was selected, a date range was given for each quarter in a given fiscal year. The event type selection listed categories from which to choose. Ground Incursion was selected from the categories provided. Under a sub category of ground incursions, runway was selected. Using these, reports of runway incursion incidents for a specific date range were retrieved.

**Research Design**

For each fiscal year, records of pilot deviations that contributed to runway incursions were identified and examined, all of which were retrieved from NASA's Aviation Safety Reporting System (ASRS). While more records can be obtained using the Runway Safety Office's Incursion database (RWS), the detail from this system was not enough to gather significant data to answer the research questions. The ASRS reports

provide each runway incursion incident with narratives from the party reporting, assessments and contributing factors, as well as a synopsis of each event. Based on the information provided in each section of the report; each runway incursion record was first classified as an operational incident, pilot deviation, or a vehicle/pedestrian deviation. This was determined by several elements of the report:

- A thorough reading of each person's narrative gave a clear indication of the events that took place. In some instances, the narrative admitted what the causes were that influenced poor decisions.
- From the assessment in each, NASA included contributing factors and situations. This detailed whether the runway incursion was caused due to human factors or perhaps weather-related issues. Further from this, NASA provided an assessment of each person involved in the runway incursion, which included the human factors directly associated with the said person. Again, in this instance it was explicitly acknowledged if the pilot deviation was a result of a breakdown in communication, or situational awareness.

With a combination of both these elements, it was easily reasoned which causal factors played a significant role from those outlined below.

Based on preliminary review, it appeared that four categories emerged as significant causal factors:

- Miscommunication – This category included reports where there was a breakdown in communication between pilot and controller. This includes instances where pilots read back incorrect instructions, responded to the incorrect

tail number, and/or totally disregarded instructions from the controller due to misunderstanding of the instructions.

- Situational Awareness – This category included reports where a pilot was not cognizant of his surroundings or situations that directly or indirectly affected his flight. This included instances where pilots may have been too focused on his/her flight and therefore was not aware of what may have been happening with other events in their vicinity or other pilots/controllers radio communications. On the other hand, it also included instances when pilots showed a lack of focus on the tasks at hand, which resulted in confusion.
- Failure to complete tasks/checklists – When pilots fail to prepare ahead of time for flight, certain tasks may go incomplete. This category included reports where a lack of planning played a role in their deviation. It also included their disobedience (negligent or not) of controller's instructions that led to unpermitted access to the runway safety area. When this was the case, miscommunication was also cited, as a pilot's disobedience to a controller's instruction is caused by miscommunication as well as a failure to complete the task assigned by the controller. In addition, this included instances when pilots forgot certain important tasks i.e. announcing positions and landing intentions over the CTAF.
- Lack of knowledge/training – This final category was added after the majority of the reports reviewed were found to be general aviation traffic, specifically student pilots. Although some instances did in fact include student pilots, there were also some that included air carrier pilots as well who were new to an aircraft type or to the airline or even to an airport.

While many of reports are exclusive to one causal factor, there were also many reports that had more than one causal factor associated with it. In some instances, all four causal factors were found in one given report.

These categories are substantiated with findings from the Aircraft Owners and Pilots Association (AOPA) runway safety course. In their findings, the same causes were found to influence pilot deviations in runway incursions – lack of preparation, lack of communication, focus, and situational awareness. Therefore, these categories were what was used to form the basis of the analysis for this study. The additional category, lack of knowledge, came about from the high number of general aviation and student pilot reports.

**Procedures**

After retrieving the data set for analysis, the data was broken down into quarters based on the FAA calendar. For the FAA the calendar year begins in October and ends in September. This means that for this study, the first quarter of data that was analyzed was October 2012 to December 2012 for the fiscal year 2013. The last set of data analyzed for that fiscal year was July to September 2013. The same was done for fiscal year 2014. The data was organized into quarters to follow the way the FAA breaks down runway statistics on their website. It was also done to make it a lot easier to analyze such a large volume of reports.

After retrieving each quarter from the ASRS database, a careful examination of each record was done. This was to determine whether or not each record fell into the category of pilot deviation, operational error, or vehicle/pedestrian deviation. In one given quarter, there were approximately 15 – 30 records. Pilot deviations accounted for

the majority of these. Those records that were determined to be operational error or vehicle/pedestrian deviation were discarded from that data set.

On a separate document, a legend was created that color-coded each of the four categories identified. Miscommunication was coded yellow; situational awareness was coded green; lack of knowledge/training was coded red; AND failure to complete tasks/checklists was coded purple. After reading each record that remained, the record number for that particular pilot deviation was highlighted with the corresponding color for the category it belonged to.

Once the data was collected, categorized, and coded, a record of each category was developed to determine which category (causal factor) was most prevalent. The following are examples of the method taken to code each report:

- Appendix A provides one example of how one record was coded into its corresponding category. In this report, the assessment gave explicit indication that the person involved had a runway incursion due to situational awareness as well as lack of training. In conjunction with this assessment and the narrative provided, this particular report was coded as situational awareness and lack of knowledge/training.
- Appendix B provides another scenario for how records were coded. In this example, the assessment stated the primary problem was ambiguous but cited that the person involved experienced confusion and distraction. Although these are normally signs of situational awareness, the narrative was read to determine whether or not there may have been other causal factors that played a role. In this instance, there was not, so it was categorized as situational awareness.

- While confusion and distraction can sometimes be associated with situational awareness, it does not have to be in every instance. For example in Appendix C, the assessments listed confusion as a potential human factor for the cause of the incident. However, it was found that miscommunication was the sole reason for the deviation. A key sentence from one of the narratives in this report stated: "The Supervisor confirmed communication problems." This, along with the other narratives confirmed that miscommunication was indeed the cause of this deviation.
- Another scenario can be seen in Appendix D. In this instance, a judgment call was made that the student pilot was not very knowledgeable on airfield markings and thus was coded lack of knowledge/training. The report assessments stated that the person flying the aircraft was a trainee and had a runway incursion due to situational awareness and a breakdown in communication. While these are both correct, it did not cite his lack of knowledge as a causal factor. Through the reading of the narrative, it was discovered that the student pilot could not distinguish between a taxiway and an active runway and as a result taxied onto the runway and caused a runway incursion. Thus, it was coded as lack of knowledge.
- For many of the reports, judgment calls were made in determining which causal factor was associated with the deviation. Much like the previous example, Appendix E also shows this. From the synopsis alone, it can be determined what causal factors were present. It reads "Pilot describes clearance issued by MIC Tower Controller as something he has never received before. Pilot questioned himself if it was alright to taxi as instructed across four runways." While the

narrative showed that the controllers instructions were unconventional, the pilot never questioned or asked for the controller to repeat his or her transmission. Instead, he took the liberty to taxi across four runways without permission to do so. To add to that, the controllers' instructions, as stated by the pilot, never mentioned a clearance to cross any runways. He should have explicitly heard this or asked for the controller to confirm his instructions. The conversation, as provided through the pilot's narrative states:

> "Aircraft X: Crystal Ground, Aircraft X, @ North of Sixty, request taxi to Wiley North."
>
> MIC Ground: "Aircraft X, taxi to Wiley North, Good night."

- In Appendix F another example of how the narrative was used to code reports to certain causal factors is provided. In this instance, situational awareness miscommunication and failure to complete tasks/checklists were all causal factors identified. While the assessments cited situational awareness and a breakdown in communication as a contributing human factor, it did not cite failure to complete tasks/checklists. Here is the narrative from the report that was used to code this record to both causal factors:

> As we took Runway 24L, both pilots commented on the large aircraft and its landing on 24R. We were cleared to takeoff on heading 230. Takeoff procedures were normal through 80 KTS. Approaching coincidental V1 and rotate speeds, both pilots noted the other aircraft did not appear to be holding short of 24R as instructed. It did indeed begin to cross our takeoff runway without slowing. As pilot flying, I rotated normally until the tail

> was clear of the runway and then aggressively rotated further while adding additional power eliminating the reduced thrust takeoff. The Captain called out, "Get it up, keep it climbing, and let's get outta here." It was my opinion that we flew directly over the other aircraft as I could see the tail section of his aircraft while looking down. Tower immediately called for the following aircraft to cancel his takeoff clearance on 24R, issued some instruction to the other aircraft, and eventually sent us to Departure.

From this narrative, it was deduced that the aircraft that crossed the active runway while an aircraft was departing failed to adhere to the controller's instructions. Thus, not only was there miscommunication and situational awareness but a failure to execute a task as instructed as well.

- Appendix G outlines an instance where three of the causal factors were identified in the assessment by NASA – communication breakdown, situational awareness, and lack of knowledge/training; and substantiated by the narrative and synopsis given. The synopsis read "A low time Private Pilot practicing full stop takeoff and landings in a PA-28 misunderstood the Tower's clearance and taxied onto the departure runway to start his takeoff roll just as an unspecified second aircraft passed closely overhead intending to land on the runway as cleared." As a result, this report was coded for all three causal factors.
- Appendix H gives another example where all four causal factors are present.

> I was working the Ground Control position and CIC combined. Aircraft X landed Runway 13R and was instructed to make a 180 and exit at A1, which is an intersection that does not cross Runway 13L. I was making a

> new ATIS when Aircraft X called for taxi from A2. It was sunset and when I scanned A2 I did not see the aircraft was between the runways. I taxied him to parking and I realized he was crossing Runway 13L. Another aircraft was in the pattern for Runway 13L and was on short final. I did not stop Aircraft X as he was already clearing the runway. Aircraft on final went around and Aircraft X was clear of the runway by the time aircraft on short final crossed the threshold. I asked LCW if Aircraft X was cleared to cross and LCW informed me Aircraft X was not instructed to cross nor did I give Aircraft X a clearance to cross. I issued the Brasher Statement but Aircraft X did not respond. I made several other attempts to contact Aircraft X on Ground Control frequency but never got a response. I should have confirmed he was at A2 and instructed him to hold short of the runway, although by the time he called for taxi he was already on the runway.

This narrative by the controller shows that the aircraft taxied across a runway without clearance and was obviously confused at the controller's initial instructions, which showed the first miscommunication error as well as a lack of situational awareness and a failure to complete the tasks assigned by the controller. His lack of knowledge also caused him to be on an active runway. Therefore, this particular report was coded for all four causal factors.

- Appendix I provides an example where the report contained no assessment and finding the causal factor relied completely on the narrative. The narrative explains:

We were running Runway 6 operations. When we are on Runway 6 our taxi routes get quite complex, Runway 18R is used as a taxiway when on Runway 6. A group of 10 planes had come in earlier in the day and they were all leaving at the time of the incident. Grumman called up to taxi out and was given the taxi instructions, taxi via Echo, Runway 18R, and Hotel, Cross Runway 18L. I believe I provided him with progressive taxi instructions as he was taxiing. Air Coupe called up right after him and was given the same taxi instructions. Air Coupe was also instructed to follow the Grumman and reported him in sight. Air Coupe was taxiing on Runway 18R as expected and was approaching his turn onto Hotel which runs adjacent to Runway 6. I was eating some food at the time and looked down to take a bite of food and that's when the Local Controller said he missed his turn and was going out onto the runway. The Local Controller had just cleared Grumman for takeoff and canceled his takeoff clearance. I instructed Air Coupe to hold position and then informed him that he missed Taxiway Hotel and had taxied out on to the runway. I then instructed him to make a 180, turn left on Taxiway Hotel, advised him of a possible pilot deviation and to call the Tower. After listening to the recorded transmissions between Air Coupe and myself it is apparent that he did not read back the taxi instructions correctly and I failed to hear the read back and correct him. Knowing that Runway 6 operations are tricky when it comes to taxiing, I should not have relied on the pilot to follow the proceeding airplane. I believe that by the pilot agreeing to follow the

proceeding airplane it allowed me to relax and miss errors in the read back.

An aircraft proceeded onto the runway without permission to do so after he missed his turn. Because he missed this turn, he failed to complete a required task and as a result ended up on an active runway.

Once each report was coded, the total number from each causal factor was counted to determine which causal factor was the most prevalent in each fiscal year. Because in some cases more than one causal factor was identified, there were far more instances of causal factors than there were of actual reports.

# CHAPTER III: Results

The data for this study originated primarily from the National Aeronautics and Space Administration's Aviation Self- Reporting database. The data included two fiscal years of runway incursions that focused primarily on pilot deviations.

## Data Analysis

To analyze the data from NASA's ASRS database, qualitative techniques of coding and categorizing were used. The type of qualitative design used was a case study as data was analyzed to understand the causes behind pilot deviations in greater depth by looking at different cases. Also, the interpretation of each case was done in order to find common themes as well as find an overall premise for this runway safety issue. From the two fiscal years examined, 188 reports of runway incursions were found. After examining each report and eliminating those that fell under operational error, and vehicle/pedestrian deviation, there were 119 reports left that fell under pilot deviations. In a comparison between fiscal year 2013 and 2014 there was a slight decrease in pilot deviations from FY2013 to FY2014, where FY2013 had a total of 61 reports and FY2014 had a total of 58 reports. This showed little significant difference. It is important to note that some reports consisted of more than one category (causal factors).

In fiscal year 2013, all four quarters showed no significant changes. As can be seen in table 1, miscommunication stayed within 7 – 9 reports per quarter; situational awareness was found in 9 – 16 reports; lack of knowledge/training stayed within 2 – 3 reports per quarter; and failure to complete tasks/checklists ranged from 6 – 9 reports per quarter. The greatest disparity was found in situational awareness. In addition to this, quarter 3 was probably the most significant as higher numbers were reported for each

causal factor during this time, with the exception of miscommunication that was found in the lowest number of reports in quarter 3. Quarter 2, however, reported the highest number of miscommunication incidents.

For fiscal year 2013, there were a total of 117 causal factors altogether that were attributed to pilot deviations. Quarter 1 had a total of 30 causal factors, where situational awareness was found in the majority of the reports and lack of knowledge/training was found in the least number of reports. Quarter 2 then decreased to a total of 26 causal factors with miscommunication and situational awareness found in most of the reports. Quarter 3 had the highest number of causal factors reported at a total of 35. Again, situational awareness was found in the majority of the reports for this quarter. Quarter 4 had 26 causal factors in all, with situational awareness found in many of the reports.

Table 1. *Pilot Deviations in Runway Incursions for FY2013.*

| **Pilot Deviations in Runway Incursions** | | | | |
|---|---|---|---|---|
| **Quarter** | Miscommunication | Situational Awareness | Lack of knowledge/training | Failure to complete tasks/checklists |
| **Q1** | 8 | 10 | 3 | 9 |
| **Q2** | 9 | 9 | 2 | 6 |
| **Q3** | 7 | 16 | 3 | 9 |
| **Q4** | 7 | 10 | 2 | 7 |

In fiscal year 2014 miscommunication and situational awareness showed big variances in reports per quarter. Table 2 describes how the causal factor of miscommunication was found in 4 – 20 reports and situational awareness was found in 5

– 19 reports. While lack of training/knowledge and failure to complete tasks/checklists had smaller figures, the disparity in numbers in comparison to fiscal year 2014 was also big, yielding 1 – 6 reports and 3 – 7 reports respectively. The most significant quarter for this fiscal year was quarter 4 as all causal factors showed a relatively huge increase from that of the previous quarters.

There were a total number of 111 causal factors found in all reports for the entire fiscal year of 2013. Quarter 1 had a total of 16 causal factors, where miscommunication was found in the majority of the report for that quarter. Quarter 2 had a total of 15 reports where situational awareness was found in most of the reports. Quarter 3 showed an increase in the number of total causal factors, where miscommunication was found in the majority of the reports. A significant increase came about in quarter 4, where the total number of causal factors increased to 52. In this quarter, miscommunication was also found in the majority of the reports with situational awareness not so far behind.

Table 2. *Pilot Deviations in Runway Incursions for FY2014.*

| **Pilot Deviations in Runway Incursions** | | | | |
|---|---|---|---|---|
| **Quarter** | Miscommunication | Situational Awareness | Lack of Knowledge/Training | Failure to complete Tasks/Checklists |
| **Q1** | 6 | 5 | 2 | 3 |
| **Q2** | 4 | 5 | 1 | 5 |
| **Q3** | 12 | 8 | 5 | 3 |
| **Q4** | 20 | 19 | 6 | 7 |

**Miscommunication.**

It was observed that miscommunication yielded a high number of pilot deviations. Figure 1 compares the percentages of instances categorized under miscommunication for fiscal year 2013 and fiscal year 2014. For fiscal year 2013, out of the 61 pilot deviations reported, 31 deviations had miscommunication listed as a causal factor, which accounts for 51% of the total number. For fiscal year 2014, the number of miscommunication causal factors increased from fiscal year 2013 with a total of 42 instances. In relation to the number of causal factors found in 2014, miscommunication was a causal factor in 72% of the total number.

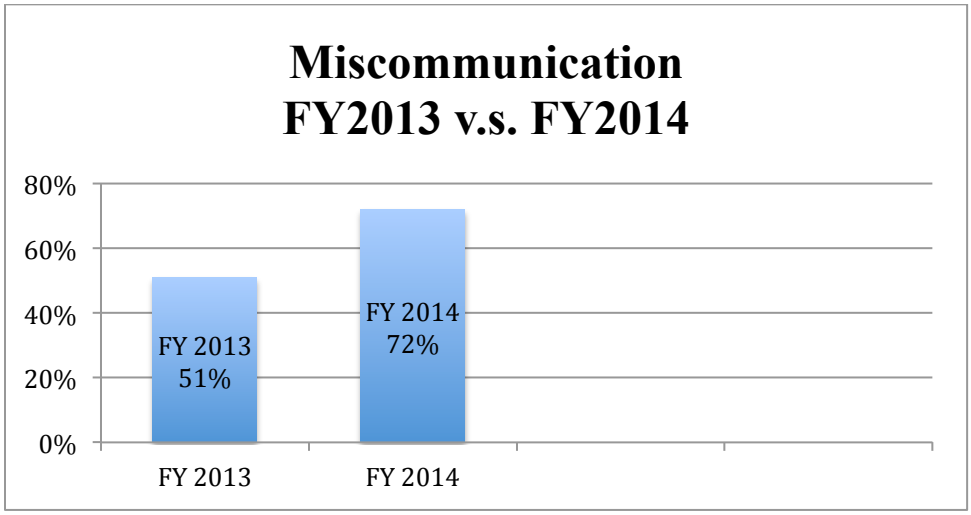


Figure 1. *Graph depicting the difference between FY2013 and FY2014 for miscommunication*

**Situational Awareness.**

Situational awareness was also found to be a significant causal factor that resulted in pilot deviations. Figure 2 compares the percentages of instances categorized under situational awareness for fiscal year 2013 and fiscal year 2014. Fiscal year 2013 reported 45 instances of pilot deviations that were categorized under situational awareness. Out of

a total of 61 reports this yielded 74% of the total number. For fiscal year 2014, there was a decrease in the number of instances that fell under the situational awareness category. There were 37 accounts reported, or 64% of the total number of reports.

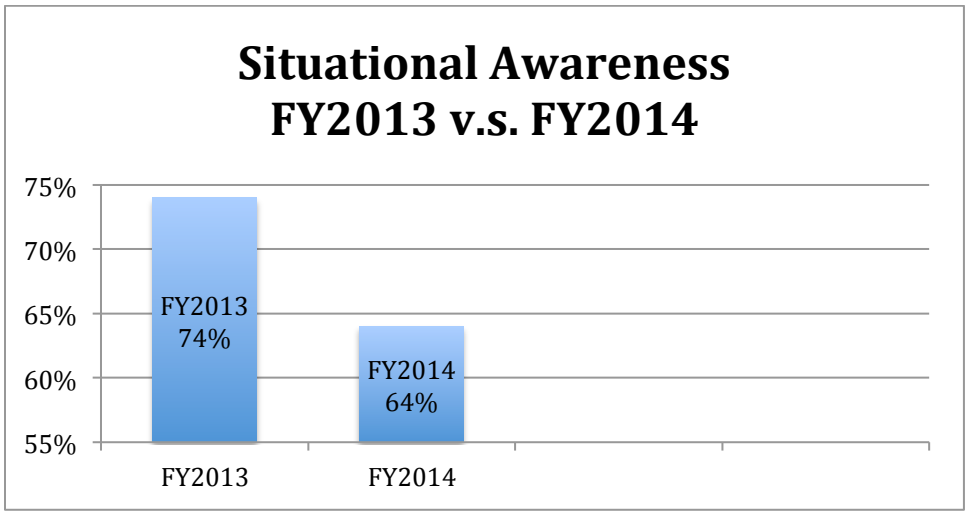


Figure 2. *Graph depicting the difference between FY2013 and FY2014 for situational awareness*

**Lack of Knowledge/Training.**

The least number of pilot deviations that were reported were in the lack of knowledge/training category. Figure 3 describes this in a chart that compares fiscal year 2013 to fiscal year 2014 for this causal factor. For fiscal year 2013, only ten instances of lack of knowledge/training appeared in the ASRS database. This yields 16% of the total number. Likewise, in fiscal year 2014, this causal factor remained the lowest of all four causal factors once again. A total of 14 accounts were reported, or 24% of the total number. As can be observed, despite the low numbers there was an increase from fiscal year 2013 to fiscal year 2014.

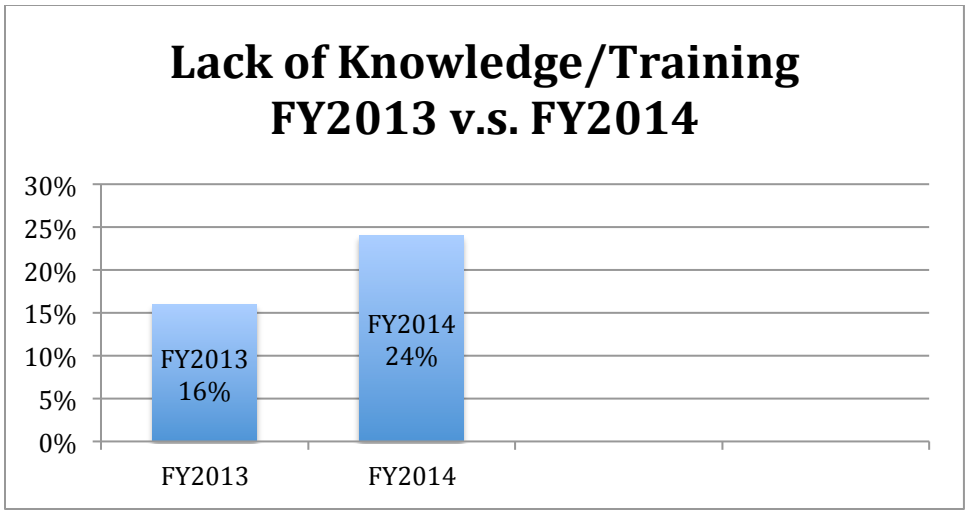


Figure 3. *Graph depicting the difference between FY2013 and FY2014 for lack of knowledge/training*

**Failure to Complete Tasks/Checklists.**

It was found that a pilot's failure to complete tasks or checklists also had a high number of results for fiscal year 2013, but fell greatly in fiscal year 2014. Figure 4 outlines the comparison between fiscal year 2013 and fiscal year 2014 for the causal factor, failure to complete tasks/checklists. It shows that for fiscal year 2013, failure to complete tasks/checklists matched that of miscommunication, yielding 31 instances out of a total 61 reports, or 51% of the total number. In fiscal year 2014, 18 accounts were reported that were a result of this causal factor. This yields 31% of the total number of reports in fiscal year 2014.

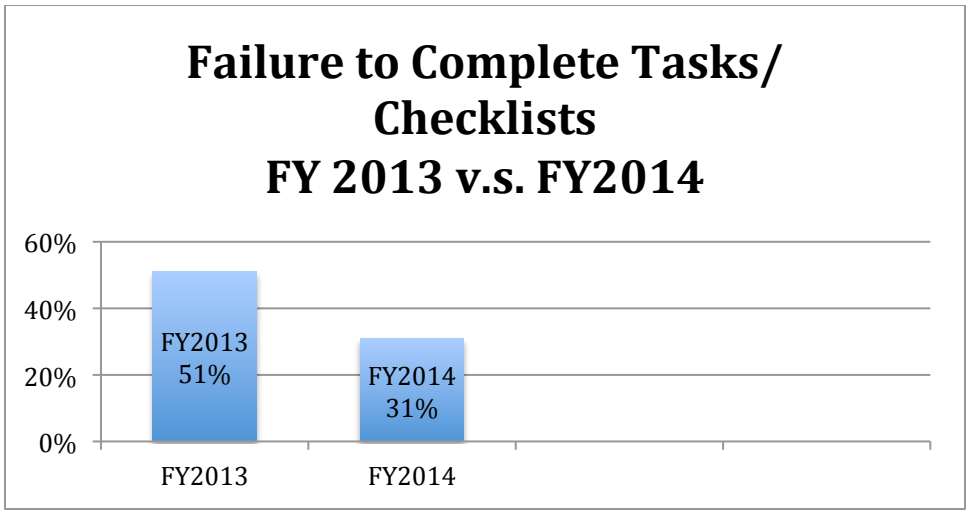


Figure 4. *Graph depicting the difference between FY2013 and FY2014 for failure to complete tasks/checklists*

Between the two fiscal years as noted, miscommunication was a significant causal factor due to its high number of reports as well as its increase from FY2013 to FY2014. The significant numbers of communication issues that were reported in FY2014 came from quarter four; and almost all of the reports were in conjunction with other causal factors. The same was true for reports that cited situational awareness and lack of knowledge/training as causal factors. From the table identified as table 2 of Chapter 3, this can be noted.

## CHAPTER IV: Discussion

The primary purpose of this study was to identify and evaluate the predominant causes of pilot deviations in runway incursions. The two research questions outlined in Chapter 1 were aimed at finding these causes, discovering the most frequent causes and further noting the trend in the causes that exist over a two-year period. While there have been many causal factors proposed, this research used those identified by AOPA, found in their runway safety course, and further evaluated their significance. In addition to those, one more causal factor was added due to the number of runway incursion incidents that included general aviation aircraft and student pilots. This causal factor was lack of knowledge/training.

There were four causal factors that were evaluated: miscommunication, situational awareness, lack of knowledge/training, and failure to complete tasks/checklists. To answer research question one, there were two predominant causal factors that contributed to pilot deviations in runway incursions. These were miscommunication and situational awareness. In FY 2013, 51% of reported runway incursions that were reported were due to miscommunication, which increased to 72% by FY2014. Situational awareness contributed to 74% of all reports in FY2013 and decreased to 64% in FY2014. The other two causal factors: lack of knowledge/training and failure to complete tasks/checklists, showed 51% or less for each fiscal year. Therefore, in terms of significance these two did not have as much impact as miscommunication and situational awareness.

While it could be concluded that situational awareness showed greater frequency as a factor than all other causal factors, in FY2014 miscommunication showed not only a

much greater increase in instances than was reported in FY2013, but a much greater increase than that of situational awareness factors in FY2014 as well. Therefore, it would not be correct to discuss one of these causal factors and disregard the other, if the root runway incursion issues are to be reduced.

It was rather interesting to find that lack of knowledge/training did not yield a higher percentage because many of the reports were from general aviation pilots. However, it was found that if in fact this was the causal factor, in most cases another causal factor was associated with it such as miscommunication or situational awareness, which explains the higher percentage for these two causal factors. In reality, there are far more incidents unreported, in particular, general aviation incidents at non-controlled fields. Although this study does not support or analyze data solely from non-controlled fields, it can be assumed that findings from non-controlled fields would produce a higher percentage for lack of knowledge/training. Similar to this causal factor, failure to complete tasks/checklists was also, in many cases, associated with another causal factor, decreasing the percentage in this particular category.

Research question two sought to find the significant trends that existed between the causal factors for FY2013 and FY2014. There were two note worthy trends that were prevalent from the comparison of both fiscal years. One trend that was commendable was the significant decrease in instances of a pilot's failure to complete tasks or assignments, which decreased by 20% over the two-year period. This decrease was surprising because this causal factor most often showed itself in conjunction with other causal factors. For instance, a pilot's miscommunication with a controller was typically the result of that pilot not following the instructions of the controller and therefore failing to complete a

required task. A pilot's lack of situational awareness could have been the result of a pilot's extreme focus on one single matter, which simultaneously led to the pilot's lack of focus on another matter, which also caused him/her to inadvertently not complete necessary tasks. Examples of both scenarios can be found in Appendix J & K respectively. In essence, miscommunication and situational awareness sometimes resulted in a pilot's failure to complete tasks/checklist, and therefore it was anticipated that this causal factor would follow the same trend as miscommunication and situational awareness. However, this was not the case. Unfortunately it was impossible to determine what caused this trend. Because the other causal factors increased it was anticipated that this would increase as well. Another trend in a comparison between both fiscal years that emerged is the increase in instances of miscommunication. As Figure 1 in chapter 3 describes, miscommunication showed an increase of 22% of the total number of pilot deviations.

**Recommendations**

One of the predominant causal factors found was miscommunication between pilots and air traffic controllers. Effective communication has always been a problem that contributed to runway incursions. Chapter 1 outlines a study in 2004 by Singh and Meier that cites effective communication as an issue in runway incursions. As the reports in this study are taken from the most recent fiscal years reported, it seems as if effective communication is still a significant problem. From their study, Singh and Meier (2004), suggests that direct communication to pilots and drivers through issuing instructions that do not rely on memory or verbal communication would improve communication. Essentially, this would eliminate information transmitted via radio communication as a

source of possible incorrect information. An independent guidance control system would directly notify flight crew of any possible runway incursion situation. This would add a layer of protection by decreasing miscommunication events for pilots. In addition, it would simultaneously reduce the radio frequency congestion and increase the productivity of the controller, which would also reduce operational errors on the part of the controller.

Preventative systems with direct notification of possible runway incursions have in fact been introduced, but only at some airports. Chapter 1 gives details on these systems that have been implemented, including: Airport Surface Detection Equipment Model X (ASDE-X), eFAROS, and Runway Status Lights. With the continued installation of these systems, it is believed that the communication gap between controllers and pilots will be greatly improved.

Another predominant causal factor found was situational awareness. This was primarily due to a lack of focus on the overall flying environment. From the reports, it seemed as if pilots were often focused on their flight alone and what was needed to successfully accomplish the same, with a disregard to external influences that affected their flight. In many instances, pilots taxied across the airfield without proper clearance and entered the runway safety zone, which indicates that they were also not readily listening to the appropriate frequency or were distracted. Appendix L outlines a report where this was found.

Yes, it is known that take off and landing are the most critical phases of flight, and during taxi, a pilot is just one step removed from either one of those situations. Therefore, the biggest recommendation is the reassurance of the sterile cockpit and the

need for designated roles in the cockpit when there is a two-man cockpit, particularly in commercial aviation operations. During such a high stress time, it can become difficult to continually assess situations. This is especially true in the case of flight when a pilot has become accustomed to flying into a certain airport. When this is the case, pilots have an expectation to taxi a certain route. Because of this, they acknowledge an air traffic controller's instructions, but taxi using previous taxi routes used to previous runways used for takeoff. Unfortunately as well, the new taxi route also produces a slight apprehension, which leads to an even greater lack of situational awareness. Regardless of the circumstances surrounding the flight, there must be at least one person monitoring the outside environment, while the other has complete guidance of the aircraft when there is a two-man crew. The pilot monitoring the outside environment should be required to verbally announce each taxiway they are passing.

For single piloted cockpits this would not be a viable option. However, pilots should still remain as vigilant and aware of the surrounding environment when taxiing to and from these critical phases of flight. Because of the increased difficulty in a single pilot cockpit, which is mainly general aviation operations, regulating agencies can argue for the need of better technology in general aviation operations by claiming that general aviation operation has a distinct need for technology to assist the pilot since there is not another person in the cockpit to do so. One technological aid that is common but not required by pilots is the electronic flight bag with moving map display.

Electronic flight bags (EFB) are another runway safety system that eliminates the need for radio communication between controllers and pilots, particularly for the issuance of progressive taxi instructions to pilots who may be unfamiliar with the airfield. This

system is cockpit-based, where pilots in the cockpit see direct information on the EFB. For electronic flight bags to be fully functional in the prevention of runway incursions, they must be associated with moving map displays. In addition to effective communication these systems also increase situational awareness by telling a pilot the exact position of the aircraft on an airfield. In 2012, the FAA approved the use of EFB's with moving map displays; however, not all pilots are so equipped (FAA, 2012). Thus, the increase in use of these, much like the other systems previously mentioned, will also help with the reduction of runway incursions as situational awareness will increase and miscommunication will decrease – predominant causal factors identified in this study that contribute to runway incursions.

**Limitations of the Study**

The limitations of this study were intrinsic in the research design. Using the ASRS database to retrieve data only provided a portion of the runway incursion incidents reported for each fiscal year. Therefore the data used does not reflect a 100% accuracy rate of what actually took place; so all runway incursions were not examined for each year. Although reporting incidents through the ASRS provides immunity for pilots, it is not required. The immunity from punitive action only works when there is reported evidence of negligent action. In the case of runway incursions, these are only reported when an air traffic controller observes such an incident. Therefore, incidents that occur at non-towered fields go unreported by air traffic control, which eliminates the need for immunity and leads to less need for pilots to make an ASRS report of a runway incursion at a non-towered field. Thus, these reports are not factored into the overall study.

Another limitation of this particular study was also intrinsic to the design. Because it was a qualitative study and coding and categorizing relied solely on the author's knowledge and opinion, what was considered miscommunication, or lack of knowledge/training, may not have been considered the same had the study been completed by someone else. While some reports showed similarities, there were also very minute differences that made it, in some cases, difficult to distinguish which causal factor should be included in each report. An instance where this was noticed was if a report included a pilot landing without clearance, it would obviously be coded as miscommunication and failure to complete task. However, in another report a pilot landed without clearance but had no radio communication and was low on fuel. ATC then used light gun signals to tell the pilot he was not cleared to land. While this may not have been coded as miscommunication or a failure to complete a task, because the pilot had no means of communicating with the air traffic controller that he had no fuel and did not have enough for a go around, another researcher might have coded that he did in fact disobey an order given by ATC which could have also compromised safety on the ground. In instances like this one, it became rather difficult to logically analyze the report for a right or wrong causal factor.

**Future Research**

Gathering data from multiple sources would have corroborated the findings and given even greater significance to the research. In light of this, data from ASRS would be used, but viewpoints on runway incursions from organizations like the Air Line Pilots Association (ALPA), Aircraft Owners and Pilots Association (AOPA) and the International Civil Aviation Organization (ICAO) would also be included. By doing this,

the data would be triangulated by credible sources that would lend even more substance to the findings.

Furthermore, after the results showed that there were not many incidents involving lack of knowledge/training that would normally be associated with training pilots, it was realized that the reason would be due to non-reporting by these pilots who have no need for immunity because they often fly at non-towered fields. Also, student pilots and low-time pilots may not realize the importance of incident reporting through the ASRS system. Therefore, gathering data from the ASRS proved to be null in this regard. If this study was to be redone, it would be interesting to find cases specifically at non-towered fields to give a better account of exactly how many runway incursion incidents there really are. To do this, the best approach would be by observations at airports with no control tower if given the permission by the airport manager. If that particular airport is currently conducting studies to implement an SMS, it would be most ideal and a win-win for both the researcher and the airport. The reason it would be difficult to ascertain data from any of the aviation databases is because the ASRS, as mentioned in the limitations, do not account for most of the general aviation traffic at non-towered fields and the Runway Safety Office database does not include non-towered fields in their search criteria. Of course the data gathered would only represent a portion of all general aviation traffic in the United States, but it would give a clearer picture of what the overall industry is facing in terms of runway incursions.

Because runway incursions have been a serious concern for years, there has been much research and many efforts to improve the problem. With the recent implementation of new technology that the FAA has tested at some airports, it would be interesting to

determine if they have helped improve the runway incursion rate. This would be done by using an airport where these are currently located, gathering the reports of incursions prior to their installation for a given time period and comparing that to reports after their installation. One airport that would be most ideal is Dallas/Fort Worth International Airport because it was a test airport for the runway status lights and the enhanced Final Approach Occupancy Signals. Likewise, the Albuquerque International Sunport would be a good airport to study the results of the electronic flight bags w/moving map display as this facility was used during testing of these in 2011.

**Conclusion**

The aviation industry has suffered from runway incursions for years, and continues to find this issue a major concern. Specifically, pilot deviations have contributed a great deal to this ongoing issue. With new technological advancements to improve runway incursions, the expectation is that there would be a significant decrease in the number of incursions that happen every year. However, their uses are only as effective once the predominant causes can pinpoint which system would work best. From this study, it was found that within pilot deviations, miscommunication and situational awareness are the predominant causal factors that contribute to runway incursions. It was also found that over a period of two years there was no significant change between these two causal factors. Many of the new systems the FAA have implemented are geared toward reducing the frequency of these causal factors; yet runway incursions continue to happen, even to this current quarter. If a significant change in the ongoing problem of pilot deviations in runway incursions is expected to come, then swift action on the implementation of each system is also required.

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# APPENDICES

## APPENDIX A: Example of coding using the assessment and narrative

**ACN: 1101386**

**Time / Day**

Date : 201307

Local Time Of Day : 0601-1200

**Place**

Locale Reference.Airport :

ZZZ.Airport

State Reference : US

Altitude.AGL.Single Value : 0

**Environment**

Flight Conditions : VMC

Weather Elements /

Visibility.Visibility : 10

Light : Daylight

**Aircraft**

Reference : X

ATC / Advisory.UNICOM : ZZZ

Aircraft Operator : Personal

Make Model Name : Cardinal

177/177RG

Crew Size.Number Of Crew : 1

Operating Under FAR Part : Part 91

Flight Plan : None

Flight Phase : Taxi

Route In Use : Direct

**Person**

Reference : 1

Location Of Person.Aircraft : X

Location In Aircraft : Flight Deck

Reporter Organization : Personal

Function.Flight Crew : Pilot Flying

Function.Flight Crew : Single Pilot

Qualification.Flight Crew : Private

Qualification.Flight Crew : Instrument

Experience.Flight Crew.Total : 1675

Experience.Flight Crew.Last 90 Days :

20

Experience.Flight Crew.Type : 700

ASRS Report Number.Accession

Number : 1101386

Human Factors : Situational Awareness

Human Factors : Training / Qualification

Human Factors : Distraction

**Events**

Anomaly.Conflict : Ground Conflict, Less Severe

Anomaly.Ground Incursion : Runway

Detector.Person : Observer

Detector.Person : Flight Crew

When Detected : Taxi

Result.Flight Crew : Became Reoriented

**Assessments**

Contributing Factors / Situations : Aircraft

Contributing Factors / Situations : Human Factors

Contributing Factors / Situations : Procedure

Primary Problem : Human Factors

**Narrative: 1**

When I was taxiing out I heard an ELT on 121.5. I asked another plane being fueled if he heard it too, but he said he only heard it when I transmitted, so maybe it was mine. I tested mine and didn't think it was on and kept taxiing out. I was at the runup area when I started programming my panel mount GPS, my portable GPS and my iPad. I also tried to figure out where the ELT was coming from. It must have taken longer than I expected because I didn't realize that the other plane was waiting to takeoff behind me. He came on the radio and said, "You know, I'm burning 30 gallons an hour sitting here." I immediately headed toward the runway to takeoff when he yelled over the radio "STOP! There's an aircraft on short final." I stopped and immediately saw the aircraft. Fortunately I did not enter the runway, but the plane on final

had the good sense to go-around. When I took the active, I saw that there were three other planes waiting to depart behind the plane. Not only was I holding things up programming three different navigation units on a perfect VFR day, but I let myself get spooked into doing something that could have been dangerous. The lesson is not to let unimportant things distract you and never lose situational awareness.

**Synopsis**

C177 pilot, distracted by programming two GPS units and an iPad, and also conscious of traffic waiting behind him, started to taxi onto the active runway causing an aircraft on final to go-around at a non-towered airport.

**APPENDIX B: Example of coding when the assessment stated primary problem as ambiguous**

**ACN: 1089541**

**Time / Day**

Date : 201305

Local Time Of Day : 1201-1800

**Place**

Locale Reference.Airport :

ACT.Airport

State Reference : TX

Altitude.AGL.Single Value : 0

**Environment**

Flight Conditions : VMC

Weather Elements /

Visibility.Visibility : 10

Light : Daylight

Ceiling.Single Value : 4000

**Aircraft**

Reference : X

ATC / Advisory.Tower : ACT

Aircraft Operator : Corporate

Make Model Name : Light Transport,

Low Wing, 2 Turbojet Eng

Crew Size.Number Of Crew : 2

Operating Under FAR Part : Part 91

Flight Plan : IFR

Mission : Passenger

Flight Phase : Taxi

Flight Phase : Landing

Route In Use : None

**Person**

Reference : 1

Location Of Person.Aircraft : X

Location In Aircraft : Flight Deck

Reporter Organization : Corporate

Function.Flight Crew : Captain

Function.Flight Crew : Pilot Flying

Qualification.Flight Crew : Air

Transport Pilot (ATP)

Qualification.Flight Crew : Flight

Instructor

Qualification.Flight Crew :

Multiengine

Experience.Flight Crew.Total : 9800

Experience.Flight Crew.Last 90 Days : 45

Experience.Flight Crew.Type : 1100

ASRS Report Number.Accession Number : 1089541

Human Factors : Confusion

Human Factors : Distraction

Analyst Callback : Completed

**Events**

Anomaly.Deviation - Procedural : Clearance

Anomaly.Ground Incursion : Runway

Detector.Person : Air Traffic Control

When Detected : Taxi

Result.Flight Crew : Became Reoriented

Result.Air Traffic Control : Issued Advisory / Alert

**Assessments**

Contributing Factors / Situations : Airport

Contributing Factors / Situations : Environment - Non Weather Related

Contributing Factors / Situations : Procedure

Primary Problem : Ambiguous

**Narrative: 1**

Upon landing at Waco airport on Runway 14, we proceeded to roll out on the full length of the runway. As we approached Taxiway B3, we were instructed by the Tower Controller to exit on Taxiway B2. At the moment, approaching B3 we assumed that B2 was the next taxiway turnoff. As we rolled off the end of Runway 14, we found ourselves on the overrun to Runway 14 (chevron taxiway marking). At this point we were approaching Runway 19 and slowed to stop to query the Tower Controller regarding our taxi instructions which did not include crossing Runway 19. Before we were able to question the Tower Controller, a second Controller instructed us to do a 180 turn on the runway and exit on Taxiway B3. As instructed, we complied with those instructions and proceeded to exit the

Runway at B3. Approximately 1 minute later, the Tower instructed us to contact the Approach/Tower phone number to discuss a possible pilot deviation. We learned during that phone conversation, that the overrun for Runway 14 is a non-movement area. Further, because we had rolled out in this non-movement area, we were in violation of a runway incursion, even though we never moved on to the adjacent Runway 19 at any point. Subsequent to our phone discussion with the Tower Supervisor, we are still rather confused as to what we did wrong other then taxing on to the overrun portion of Runway 14. It should be noted there are no airport signs, directions or notes on the airport surface or more importantly, on our airport runway charts that identify this area as a non-movement area.

**Callback: 1**

The reporter stated that he is still unclear what the runway incursion event was which the Controller referenced. His concentration was on the short field landing and at the time he was traveling at no more than 5 miles per hour and missed the taxiway sign so thought what turned out to be the overrun was Taxiway B-3. The reporter stated that the Controller whom he spoke with stated that they were having "all kinds of problems with aircraft in that area." What the reporter believes is that the signage on Runway 14 approaching the runway end should state that area is a non-movement area because it is not possible to see the overrun chevrons in a short aircraft.

**Synopsis**

A pilot landed on ACT Runway 14 and after missing Taxiway B-3 entered the area beyond the runway's end where he was given a 180 degree turn to Taxiway B-3 and advised of a runway incursion in the non-movement area.

**APPENDIX C: Example of coding situational awareness using key words in the assessment and the narrative**

**ACN: 1122321**

**Time / Day**

Date : 201310

Local Time Of Day : 1801-2400

**Place**

Locale Reference.Airport : HOU.Airport

State Reference : TX

Altitude.AGL.Single Value : 0

**Aircraft : 1**

Reference : X

ATC / Advisory.Ground : HOU

Aircraft Operator : Air Carrier

Make Model Name : B737-700

Crew Size.Number Of Crew : 2

Operating Under FAR Part : Part 121

Flight Plan : IFR

Mission : Passenger

Flight Phase : Taxi

Route In Use : None

**Aircraft : 2**

ATC / Advisory.Tower : HOU

Make Model Name : Super King Air 200

Flight Plan : IFR

Flight Phase : Takeoff

Route In Use : None

**Aircraft : 3**

Reference : Z

ATC / Advisory.Ground : HOU

Make Model Name : No Aircraft

**Person : 1**

Reference : 1

Location Of Person.Facility : HOU.Tower

Reporter Organization : Government

Function.Air Traffic Control : Ground

Qualification.Air Traffic Control : Fully Certified

ASRS Report Number.Accession Number : 1122321

Human Factors : Confusion

Human Factors : Communication Breakdown

Communication Breakdown.Party1 : ATC

Communication Breakdown.Party2 : Flight Crew

Communication Breakdown.Party2 : Ground Personnel

**Person : 2**

Reference : 2

Location Of Person.Aircraft : X

Location In Aircraft : Flight Deck

Reporter Organization : Air Carrier

Function.Flight Crew : First Officer

Experience.Flight Crew.Last 90 Days : 141

Experience.Flight Crew.Type : 7400

ASRS Report Number.Accession Number : 1123053

**Person : 3**

Reference : 3

Location Of Person.Aircraft : X

Location In Aircraft : Flight Deck

Reporter Organization : Air Carrier

Function.Flight Crew : Captain

Qualification.Flight Crew : Air Transport Pilot (ATP)

Experience.Flight Crew.Last 90 Days : 162

ASRS Report Number.Accession Number : 1123045

**Events**

Anomaly.ATC Issue : All Types

Anomaly.Deviation - Procedural : Published Material / Policy

Anomaly.Ground Incursion : Runway

Anomaly.Ground Event / Encounter : Other / Unknown

Detector.Person : Air Traffic Control

Result.Air Traffic Control : Issued New Clearance

**Assessments**

Contributing Factors / Situations : Human Factors

Contributing Factors / Situations : Procedure

Primary Problem : Human Factors

**Narrative: 1**

A B737-700 contacted me leaving the runway. I instructed him to hold short of Runway 22 on Taxiway Mike. He read back the hold short instructions. Ops 5 was conducting driver training at the time. Ops 5 requested to cross the from the west side of the airport to the east side of the airport. I instructed Ops 5 that they needed to cross at a different location. Ops 5 then moved to a crossing that did not require him to travel down the runway, only to cross the runway. I then coordinated my crossings with Local Control, and instructed Ops 5 to cross Runway 17 and to hold short of Runway 12R on H. I then gave instructions to numerous other aircraft. I then saw the B737-700 taxiing extremely fast and realized he was not going to be able to hold short of the runway. I saw a Super King Air 200 on departure roll and yelled for the B737-700 to "STOP STOP STOP STOP." After listening to the tape, the Ops vehicle had drawn out his response and had come back with his hold short again without using his Ops 5 ID, and apparently the B737-700 took Ops 5 instruction(s). I never instructed the B737-700 to cross Runway 22. I never heard him change his gate or hold short instructions, I believe due to frequency congestion. Driver training should be done at less congested times.

**Narrative: 2**

After landing in HOU, we told Ground we were parking at Gate XX. Told to taxi via M and hold short of Runway 22. After calling Ops, we called

Ground changing the gate to XX. The next transmission both pilots heard was "hold short of 12L at H." We readback clearance with our call sign. Both the Captain and I verified we were to hold short of 12L. Approaching Runway 22, another Controller told us to stop. We stopped but our nose was past the hold short line. Captain spoke to the Tower Supervisor after parking at gate. The Supervisor confirmed communication problems. Preventative Measures, ATC needs to confirm readbacks. All parties use call signs like we did.

**Narrative: 3**

While taxiing toward our gates on Taxiway Mike, we were told to hold short of Runway 22. We told Ground of our new gate assignment and we then were instructed to hold short of Runway 12 on Taxiway Hotel. We repeated our clearance back and we confirmed our clearance with each other. As we were approaching Runway 22, a Controller came on the frequency and told us to stop. I stopped the aircraft but our nose had crossed the hold short line. After arriving at the gate, I called the Tower Supervisor. After he reviewed the tapes, he informed me that the Ground Controller had given a clearance to an airport vehicle to hold short of Runway 12 but the vehicle did not read back his call sign along with the instructions and just said hold short of Runway 12 on Hotel. We took that as Ground instructing us to hold short of Runway 12 at Hotel and we read back that clearance with our call sign. There was no correction from Ground so we continued until told to stop. Preventative measures, all traffic, including airport vehicles and ATC controllers must use standard phraseology and call signs.

**Synopsis**

HOU Controller described a runway incursion involving an inbound air carrier, the reporter listing communications problems and airport driver training as contributing to the event.

## APPENDIX D: Example of coding using the narrative and not the assessment

**ACN: 1081747**

**Time / Day**

Date : 201304

Local Time Of Day : 1201-1800

**Place**

Locale Reference.Airport : JRF.Airport

State Reference : HI

Altitude.AGL.Single Value : 0

**Environment**

Flight Conditions : VMC

Weather Elements /

Visibility.Visibility : 10

Light : Daylight

Ceiling.Single Value : 4000

**Aircraft**

Reference : X

Aircraft Operator : FBO

Make Model Name : Small Aircraft

Operating Under FAR Part : Part 91

Flight Plan : None

Mission : Training

Flight Phase : Taxi

Route In Use : Visual Approach

**Component**

Aircraft Component : Engine

Aircraft Reference : X

Problem : Malfunctioning

**Person : 1**

Reference : 1

Location Of Person.Aircraft : X

Location In Aircraft : Flight Deck

Reporter Organization : FBO

Function.Flight Crew : Pilot Not

Flying

Function.Flight Crew : Instructor

Qualification.Flight Crew :

Multiengine

Qualification.Flight Crew : Instrument

Qualification.Flight Crew : Flight

Instructor

Qualification.Flight Crew : Commercial

Experience.Flight Crew.Total : 1100

Experience.Flight Crew.Last 90 Days : 70

Experience.Flight Crew.Type : 30

ASRS Report Number.Accession Number : 1081747

Human Factors : Communication Breakdown

Communication Breakdown.Party1 : Flight Crew

Communication Breakdown.Party2 : Flight Crew

Analyst Callback : Attempted

**Person : 2**

Reference : 2

Location Of Person.Aircraft : X

Location In Aircraft : Flight Deck

Reporter Organization : Personal

Function.Flight Crew : Trainee

Function.Flight Crew : Pilot Flying

Qualification.Flight Crew : Private

Qualification.Flight Crew : Instrument

Experience.Flight Crew.Total : 222

Experience.Flight Crew.Last 90 Days : 17

Experience.Flight Crew.Type : 34

ASRS Report Number.Accession Number : 1081741

Human Factors : Situational Awareness

Human Factors : Communication Breakdown

Communication Breakdown.Party1 : Flight Crew

Communication Breakdown.Party2 : Flight Crew

**Events**

Anomaly.Aircraft Equipment Problem : Less Severe

Anomaly.Deviation - Procedural : Published Material / Policy

Anomaly.Deviation - Procedural : Clearance

Anomaly.Ground Incursion : Runway

Detector.Person : Flight Crew

When Detected : Taxi

Result.Flight Crew : Became Reoriented

Result.Air Traffic Control : Issued New Clearance

Result.Aircraft : Equipment Problem Dissipated

**Assessments**

Contributing Factors / Situations : Aircraft

Contributing Factors / Situations : Human Factors

Primary Problem : Human Factors

**Narrative: 1**

The maneuver that was being practiced was stop and go with simulated single engine out to landing. The single engine to landing on Runway 4R was successful to a full stop on centerline. The flaps were raised and throttles were in takeoff position. Only the right engine responded to throttle movements and the left engine had died. At this time, I re-verified that mixtures were rich, propellers to full, boost pumps on. The left fuel selector showed it was in cross-feed position while the right engine was in the main tanks position--main tanks are required for takeoff and landings. My student must have set the left engine fuel selector cross feed as part of a simulated failed left engine during cruise and forgot to set it to main tanks to accomplish the Before Landing Checklist. Thus, the left engine died.

As I was restarting the left engine after the third try, the Tower Controller was getting annoyed and told us to taxi off Runway 4R via left turn on Taxiway C and hold short of Runway 4R left. At this airport, there is a third runway, which intersects both 4L and 4R with no intersection sign. My student

mistakenly turned onto Runway 29 thinking it was Taxiway C, because C was the next taxi after the intersection. By the time my student reacted to my instructions to stop the airplane, my student was already taxiing on Runway 29. Tower was then really really miffed and told us that we taxied onto an active runway. Tower then redirected us to turn off Runway 4L at Charlie Intersection, which we did. There are not any brake pedals for the right seat, which I was occupying.

By this time, I too was speaking sternly to my student to make sure he understood the gravity of what just happened and to emphasize that HE and only HE has the brakes. We called Ground frequency to reposition for takeoff and requested a north departure. We then changed frequency to tower and requested to take off and depart to the north. We took off Runway 4L without further incidents. There were varying factors for this incident--engine dying, student was too distraught to remember about his brakes and misreading of a taxiway. The airport needs to add a runway intersection sign as well as their lines needs to be repainted.

**Narrative: 2**

[We] landed during an engine out landing drill. In this case it was the left engine (critical engine) that was allowed to idle. After landing the left engine quit although there was adequate fuel in all tanks, propellers at full RPM, mixtures full [rich], and the electric boost pumps were on. We reported engine trouble to the Tower and after several attempts, we were able to restart the left engine. The Tower instructed us to Taxi off of Runway 4R to the left via taxiway

"CHARLIE" and hold short of Runway 4L. We ended up taxiing off of Runway 4R onto Runway 29. The Tower then redirected us right turn on Runway 4L then left at "CHARLIE" off of Runway 4L. Then the Tower directed us to contact Ground. Ground Control got us back into sequence for departure from Runway 4L.

**Synopsis**

Small aircraft student and instructor pilots had difficulty restarting an engine following a simulated single engine approach and landing JRF airport. When the engine was restarted, the student mistook the crossing runway for the intended taxiway until advised by the instructor and the Tower. The Tower provided new taxi instructions and the aircraft cleared the active runway environment.

## APPENDIX E: Example of coding using the synopsis and narrative

**ACN: 1180178**

**Time / Day**

Date : 201406

Local Time Of Day : 1801-2400

**Place**

Locale Reference.Airport :

MIC.Airport

State Reference : MN

Altitude.AGL.Single Value : 0

**Environment**

Flight Conditions : VMC

Light : Night

**Aircraft**

Reference : X

ATC / Advisory.Ground : MIC

ATC / Advisory.Tower : MIC

Aircraft Operator : Personal

Make Model Name : Small Aircraft,

High Wing, 1 Eng, Fixed Gear

Crew Size.Number Of Crew : 1

Operating Under FAR Part : Part 91

Mission : Personal

Flight Phase : Taxi

**Person**

Reference : 1

Location Of Person.Aircraft : X

Location In Aircraft : Flight Deck

Reporter Organization : Personal

Function.Flight Crew : Pilot Flying

Function.Flight Crew : Single Pilot

Qualification.Flight Crew : Private

Experience.Flight Crew.Total : 149

Experience.Flight Crew.Last 90 Days :

18

Experience.Flight Crew.Type : 149

ASRS Report Number.Accession

Number : 1180178

Human Factors : Confusion

**Events**

Anomaly.ATC Issue : All Types

Anomaly.Deviation - Procedural : Published Material / Policy

Anomaly.Deviation - Procedural : Clearance

Anomaly.Ground Incursion : Runway

Detector.Person : Flight Crew

When Detected : Taxi

Result.Flight Crew : Returned To Clearance

**Assessments**

Contributing Factors / Situations : Procedure

Primary Problem : Procedure

**Narrative: 1**

I was inbound to land at MIC and contacted MIC Tower with initial position report. I was instructed by the Tower Controller to "Enter Right Base 32R". Continuing inbound, I set up my approach, entered right base and was on 1.5 NM final for 32R and had not received clearance to land. I contacted Tower and informed them of present position (1.5 NM final) and was given clearance to land. After landing, I requested taxi to self-serve pumps. Taxi instructions were provided by Tower Controller and I taxied to pumps to refuel. After refueling, I started up and contacted MIC Ground Controller with request to taxi to hangar.

Conversation: "Aircraft X: Crystal Ground, Aircraft X, @ North of Sixty, request taxi to Wiley North."
MIC Ground: "Aircraft X, taxi to Wiley North, Good night."

Having flown at MIC for 2.5 years now and having always received progressive taxi instructions, I was a little confused. However, with no other traffic on the field or in the pattern, I proceeded to taxi to Wiley North via

"normal" routing that I have received in the past ensuring that I cleared final on each runway that I crossed prior to crossing. This caused me to cross 4 runways (6R; 6L; 14R; 14L) without explicit clearance. I assumed the taxi clearance I was given "Aircraft X, taxi to Wiley North" gave me implied clearance to cross these runways and proceed own navigation. I also assumed that once I had crossed runways 6R/6L if there was a problem with the Controller, I would have been contacted via radio as I was still on Ground frequency.

Past taxi instructions from my position on the airport (North of Sixty) to the hangars would have been: "Aircraft X, taxi to Wiley North via E, E4, C cross 6R/6L, hold short 14R." Generally after crossing 6L, Controller would issue amended clearance to cross 14R/14L continue to Wiley North.

In a review of recent changes to the FARs, I noted that section (i) of FAR, 91.129 has been changed. It appears under the old FAR, my actions were appropriate as the taxi clearance I received was permission to cross all active runways that intersected my taxi route. FAR, Sec. 91.129, "Operations in Class D Airspace....(i) Takeoff, landing, taxi clearance. No person may, at any airport with an operating Control Tower, operate an aircraft on a runway or taxiway, or takeoff or land an aircraft, unless an appropriate clearance is received from ATC. A clearance to taxi to the takeoff runway assigned to the aircraft is not a clearance to cross that assigned takeoff runway, or to taxi on that runway at any point, but is a clearance to cross other runways that intersect the taxi

route to that assigned takeoff runway."

A clearance to taxi to any point other than an assigned takeoff runway is clearance to cross all runways that intersect the taxi route to that point. Amendment 91, effective 5/14/2012....(i) "Takeoff, landing, taxi clearance. No person may, at any airport with an operating control tower, operate an aircraft on a runway or taxiway, or takeoff or land an aircraft, unless an appropriate clearance is received from ATC." Lesson learned from this incident is to clarify any and all clearances received from ATC if in doubt.

**Synopsis**

Pilot describes clearance issued by MIC Tower Controller as something he has never received before. Pilot questioned himself if it was alright to taxi as instructed across four runways.

## APPENDIX F: Example of coding using the narrative

**ACN: 1095186**

**Time / Day**

Date : 201306

Local Time Of Day : 1201-1800

**Place**

Locale Reference.Airport :

LGB.Airport

State Reference : CA

Relative Position.Distance.Nautical

Miles : 0

Altitude.AGL.Single Value : 0

**Environment**

Flight Conditions : Marginal

Weather Elements / Visibility : Fog

Weather Elements /

Visibility.Visibility : 6

Light : Daylight

Ceiling.Single Value : 1000

RVR.Single Value : 10000

**Aircraft**

Reference : X

ATC / Advisory.Tower : LGB

Aircraft Operator : Personal

Make Model Name : Skyhawk

172/Cutlass 172

Crew Size.Number Of Crew : 1

Operating Under FAR Part : Part 91

Flight Plan : IFR

Mission : Personal

Flight Phase : Landing

Route In Use : Vectors

**Person**

Reference : 1

Location Of Person.Aircraft : X

Location In Aircraft : Flight Deck

Reporter Organization : Personal

Function.Flight Crew : Single Pilot

Function.Flight Crew : Pilot Flying

Qualification.Flight Crew : Instrument

Qualification.Flight Crew :

Commercial

Experience.Flight Crew.Total : 950

Experience.Flight Crew.Last 90 Days : 30

Experience.Flight Crew.Type : 620

ASRS Report Number.Accession Number : 1095186

Human Factors : Confusion

Human Factors : Situational Awareness

**Events**

Anomaly.Ground Incursion : Runway

Detector.Person : Flight Crew

Result.Air Traffic Control : Issued Advisory / Alert

**Assessments**

Contributing Factors / Situations : Airport

Contributing Factors / Situations : Human Factors

Contributing Factors / Situations : Procedure

Primary Problem : Human Factors

**Narrative: 1**

I'm writing to call your attention to a potentially unsafe condition at Long Beach, CA airport (LGB). LGB's runway pattern consists of four about 6,000 FT runways formed in a rectangle bisected at two corners by a longer about 10,000 runway, Runway 30/12. Runway 30/12 is sufficiently long that its two end sections protrude well outside the "rectangle" formed by the smaller runways, and are themselves sufficient to land a C-172 on. In this case I completed an ILS approach to Runway 30, landed at the numbers, and then turned off to the left at the first opportunity. This opportunity turned out to be the displaced threshold area for Runway 25L. The Tower noted very nicely: "We don't do that here," and gave progressive instructions to a connecting taxiway. I note the

following: (1) there was no double yellow line prohibiting such a turnoff, (2) just beyond Runway 25L there is a taxiway parallel to Runways 25; however, the signage is dense and the directions of the taxi arrows are ambiguous, and (3) given traffic at LGB consists in good part of closely spaced jet traffic, it is a great idea to exit the "active" quickly. I learned later, upon departing the next day, that both Runway 30 and Runway 25L are often BOTH active. Obviously, it is not a great idea to have aircraft taxiing through the threshold area for an active runway. Upon further investigation, I learned LGB is Number 5 in the frequency of runway incursions nationwide, so I'm guessing I'm hardly the first person to have expressed concern. Possible mitigations, none perfect, include:--painting a double yellow line across where the threshold to Runway 25L crosses Runway 30, --improving the signage, or worst of all, --closing Runways 25 when Runway 30 is active. By the way, this same situation exists at other corners of the "rectangle" at LGB, too.

**Synopsis**

C172 pilot experienced a runway incursion at LGB. Reporter stated confusing signage was a contributing factor.

## APPENDIX G: Example of coding using the assessment and narrative

**ACN: 1138890**

**Time / Day**

Date : 201311

Local Time Of Day : 1201-1800

**Place**

Locale Reference.Airport : SSF.Airport

State Reference : TX

Altitude.AGL.Single Value : 0

**Environment**

Flight Conditions : VMC

Weather Elements /

Visibility.Visibility : 10

Weather Elements / Visibility.Other

Light : Daylight

Ceiling.Single Value : 22000

**Aircraft : 1**

Reference : X

ATC / Advisory.Tower : SSF

Aircraft Operator : Personal

Make Model Name : PA-28

Cherokee/Archer/Dakota/Pillan/Warrio

r

Crew Size.Number Of Crew : 1

Operating Under FAR Part : Part 91

Flight Plan : VFR

Mission : Personal

Flight Phase : Takeoff

**Aircraft : 2**

Reference : Y

ATC / Advisory.Tower : SSF

Aircraft Operator : Personal

Make Model Name : Beechcraft /

Beech Aircraft Corp Undifferentiated

or Other Model

Operating Under FAR Part : Part 91

Mission : Personal

Flight Phase : Final Approach

Route In Use : Visual Approach

Airspace.Class D : SSF

**Person**

Reference : 1

Location Of Person.Aircraft : X

Location In Aircraft : Flight Deck

Reporter Organization : Personal

Function.Flight Crew : Single Pilot

Qualification.Flight Crew : Private

Experience.Flight Crew.Total : 196

Experience.Flight Crew.Last 90 Days : 2.9

Experience.Flight Crew.Type : 196

ASRS Report Number.Accession Number : 1138890

Human Factors : Communication Breakdown

Human Factors : Confusion

Human Factors : Training / Qualification

Human Factors : Situational Awareness

Communication Breakdown.Party1 : Flight Crew

Communication Breakdown.Party2 : ATC

**Events**

Anomaly.Conflict : Ground Conflict, Critical

Anomaly.Deviation - Procedural : Clearance

Anomaly.Ground Incursion : Runway

Detector.Person : Flight Crew

Miss Distance.Horizontal : 200

Miss Distance.Vertical : 75

Were Passengers Involved In Event : N

When Detected : In-flight

Result.General : None Reported / Taken

**Assessments**

Contributing Factors / Situations : Human Factors

Primary Problem : Human Factors

**Narrative: 1**

I was practicing touch and go's at Stinson Municipal Airport, and had been cleared for the option. I [advised my intentions were to make] a full

stop, [taxi back for another takeoff] and asked to fly a right pattern when I departed, as the normal pattern is left.

I understood the controller to give me that permission as he [provided] taxi instructions and, I thought, told me I was cleared to take off. I proceeded to the end of the taxiway and paused before turning onto the runway. Hearing no hold short instruction, I turned onto Runway 14 for take-off.

As I started rolling, another aircraft that was not visible because of trees at the edge of the runway flew over me while coming in for a landing. The estimated horizontal distance was 150-200 feet and estimated vertical distance was 75 feet. The pilot of the landing plane called out to the controller that there was another plane on the runway. I was instructed to leave the runway and proceed to the ramp until I was contacted by the controller, which I did.

**Synopsis**

A low time Private Pilot practicing full stop takeoff and landings in a PA-28 misunderstood the Tower's clearance and taxied onto the departure runway to start his takeoff roll just as an unspecified second aircraft passed closely overhead intending to land on the runway as cleared.

**APPENDIX H: Example showing all four causal factors present in one report**

**ACN: 1195922**

**Time / Day**

Date : 201408

Local Time Of Day : 0001-0600

**Place**

Locale Reference.Airport : BFI.Airport

State Reference : WA

Altitude.AGL.Single Value : 0

**Aircraft**

Reference : X

ATC / Advisory.Ground : BFI

Aircraft Operator : Personal

Make Model Name : Small Aircraft, Low Wing, 1 Eng, Fixed Gear

Crew Size.Number Of Crew : 1

Operating Under FAR Part : Part 91

Mission : Personal

Flight Phase : Taxi

Route In Use : None

**Person**

Reference : 1

Location Of Person.Facility : BFI.Tower

Reporter Organization : Government

Function.Air Traffic Control : Ground

Qualification.Air Traffic Control : Fully Certified

Experience.Air Traffic Control.Time Certified In Pos 1 (mon) : 6

ASRS Report Number.Accession Number : 1195922

Human Factors : Confusion

Human Factors : Training / Qualification

Human Factors : Communication Breakdown

Human Factors : Distraction

Communication Breakdown.Party1 : ATC

Communication Breakdown.Party2 : Flight Crew

**Events**

Anomaly.ATC Issue : All Types

Anomaly.Deviation - Procedural : Published Material / Policy

Anomaly.Deviation - Procedural : Clearance

Anomaly.Ground Incursion : Runway

Detector.Person : Flight Crew

Result.Flight Crew : Executed Go Around / Missed Approach

**Assessments**

Contributing Factors / Situations : Human Factors

Contributing Factors / Situations : Procedure

Primary Problem : Procedure

**Narrative: 1**

I was working the Ground Control position and CIC combined. Aircraft X landed Runway 13R and was instructed to make a 180 and exit at A1, which is an intersection that does not cross Runway 13L. I was making a new ATIS when Aircraft X called for taxi from A2. It was sunset and when I scanned A2 I did not see the aircraft was between the runways. I taxied him to parking and I realized he was crossing Runway 13L. Another aircraft was in the pattern for Runway 13L and was on short final. I did not stop Aircraft X as he was already clearing the runway. Aircraft on final went around and Aircraft X was clear of the runway by the time aircraft on short final crossed the threshold.

I asked LCW if Aircraft X was cleared to cross and LCW informed me Aircraft X was not instructed to cross nor did I give Aircraft X a clearance to cross. I issued the Brasher Statement but Aircraft X did not respond. I made several other attempts to contact Aircraft X on Ground Control

| | |
|---|---|
| frequency but never got a response. | BFI Ground Controller reports of an aircraft taxiing across a runway that the aircraft was never cleared to cross. The Ground Controller looked for the aircraft, didn't see it, and issued instructions. |
| I should have confirmed he was at A2 and instructed him to hold short of the runway, although by the time he called for taxi he was already on the runway. | |

**Synopsis**

**APPENDIX I: Example of a report with no assessment**

**ACN: 1142918**

**Time / Day**

Date : 201401

Local Time Of Day : 0601-1200

**Place**

Locale Reference.Airport :

ZZZ.Airport

State Reference : US

**Aircraft : 1**

Reference : X

ATC / Advisory.Tower : ZZZ

Make Model Name : Aircoupe A2

Crew Size.Number Of Crew : 1

Flight Plan : VFR

Flight Phase : Taxi

Route In Use : None

**Aircraft : 2**

Reference : Y

ATC / Advisory.Tower : ZZZ

Make Model Name : Grumman American

Crew Size.Number Of Crew : 1

Flight Plan : VFR

Flight Phase : Taxi

Route In Use : None

**Person**

Reference : 1

Location Of Person.Facility :

ZZZ.Tower

Reporter Organization : Government

Function.Air Traffic Control : Ground

Qualification.Air Traffic Control :

Fully Certified

**Events**

Anomaly.ATC Issue : All Types

Anomaly.Deviation - Procedural :

Published Material / Policy

Anomaly.Deviation - Procedural :

Clearance

Anomaly.Ground Incursion : Runway Detector.Person : Air Traffic Control

**Assessments**

Contributing Factors / Situations : Human Factors

Contributing Factors / Situations : Procedure

Primary Problem : Human Factors

**Narrative: 1**

We were running Runway 6 operations. When we are on Runway 6 our taxi routes get quite complex, Runway 18R is used as a taxiway when on Runway 6. A group of 10 planes had come in earlier in the day and they were all leaving at the time of the incident. Grumman called up to taxi out and was given the taxi instructions, taxi via Echo, Runway 18R, and Hotel, Cross Runway 18L. I believe I provided him with progressive taxi instructions as he was taxiing. Air Coupe called up right after him and was given the same taxi instructions. Air Coupe was also instructed to follow the Grumman and reported him in sight. Air Coupe was taxiing on Runway 18R as expected and was approaching his turn onto Hotel which runs adjacent to Runway 6. I was eating some food at the time and looked down to take a bite of food and that's when the Local Controller said he missed his turn and was going out onto the runway. The Local Controller had just cleared Grumman for takeoff and canceled his takeoff clearance. I instructed Air Coupe to hold position and then informed him that he missed Taxiway Hotel and had taxied out on to the runway. I then instructed him to make a 180, turn left on Taxiway Hotel, advised him of a possible pilot deviation and to call the Tower. After listening to the recorded transmissions between Air Coupe and myself it is

apparent that he did not readback the taxi instructions correctly and I failed to hear the readback and correct him. Knowing that Runway 6 operations are tricky when it comes to taxiing, I should not have relied on the pilot to follow the proceeding airplane. I believe that by the pilot agreeing to follow the proceeding airplane it allowed me to relax and miss errors in the readback.

**Synopsis**

Ground Controller taxiing multiple aircraft to the runway with a "follow the preceding aircraft" type clearance observed one of the aircraft entering the runway after the preceding departure.

## APPENDIX J: Example of miscommunication in conjunction with failure to complete tasks/checklists

**ACN: 1086805**

**Time / Day**

Date : 201305

Local Time Of Day : 1801-2400

**Place**

Locale Reference.Airport : LAX.Airport

State Reference : CA

Altitude.AGL.Single Value : 0

**Environment**

Flight Conditions : VMC

Light : Night

**Aircraft**

Reference : X

ATC / Advisory.Tower : LAX

Aircraft Operator : Air Carrier

Make Model Name : A319

Crew Size.Number Of Crew : 2

Operating Under FAR Part : Part 121

Flight Plan : IFR

Mission : Passenger

Flight Phase : Taxi

**Person**

Reference : 1

Location Of Person.Aircraft : X

Location In Aircraft : Flight Deck

Reporter Organization : Air Carrier

Function.Flight Crew : First Officer

Function.Flight Crew : Pilot Not Flying

Qualification.Flight Crew : Air Transport Pilot (ATP)

ASRS Report Number.Accession Number : 1086805

Human Factors : Communication Breakdown

Human Factors : Confusion

Human Factors : Distraction

Communication Breakdown.Party1 : Flight Crew

Communication Breakdown.Party2 : ATC

**Events**

Anomaly.ATC Issue : All Types

Anomaly.Deviation - Procedural : Clearance

Anomaly.Ground Incursion : Runway

Detector.Person : Air Traffic Control

When Detected : Taxi

Result.General : None Reported / Taken

**Assessments**

Contributing Factors / Situations : Airport

Contributing Factors / Situations : Chart Or Publication

Contributing Factors / Situations : Procedure

Primary Problem : Chart Or Publication

**Narrative: 1**

Cleared to taxi to [Runway] 24L via E. Captain taxiing, I'm finishing the Before Takeoff checklist as we come to the end of [Runway] 24L. After sitting at the hold short line for a minute or so Tower questioned where we are. I responded holding short of [Runway] 24L, he sounds irritated and says there is a sign that we are supposed to hold short of when cleared to [Runway] 24L. Neither the Captain nor I were familiar with this procedure or had seen the sign. There is no note or mention of it anywhere on the charts or anywhere that we could find later and Ground Control made no mention of it.

Noting such a hold line on the airport diagram would be helpful. There is a similar hold line for [Runway] 25R that is noted on the chart. Why not the

one on [Runway] 24L? Why doesn't Ground Control give specific hold short instructions in taxi clearance?

**Synopsis**

An A319 taxied to the end of LAX Taxiway E and was admonished for failing to hold short at the specified hold short sign but the crew did not see a sign nor is a hold short note printed on the airport diagram as it is for Runway 25R.

**APPENDIX K: Example of situational awareness in conjunction with failure to complete tasks/checklists**

**ACN: 1098330**

**Time / Day**

Date : 201306

Local Time Of Day : 0601-1200

**Place**

Locale Reference.Airport :

TRK.Airport

State Reference : CA

Altitude.AGL.Single Value : 0

**Environment**

Flight Conditions : VMC

Weather Elements /

Visibility.Visibility : 10

Ceiling.Single Value : 20000

RVR.Single Value : 10

**Aircraft**

Reference : X

ATC / Advisory.CTAF : TRK

Aircraft Operator : Personal

Make Model Name : Skyhawk

172/Cutlass 172

Crew Size.Number Of Crew : 1

Operating Under FAR Part : Part 91

Flight Plan : VFR

Mission : Personal

Flight Phase : Taxi

Route In Use : None

**Component**

Aircraft Component : Air/Ground

Communication

Aircraft Reference : X

Problem : Improperly Operated

**Person**

Reference : 1

Location Of Person.Aircraft : X

Location In Aircraft : Flight Deck

Reporter Organization : Personal

Function.Flight Crew : Single Pilot

Qualification.Flight Crew : Commercial

Experience.Flight Crew.Total : 515

Experience.Flight Crew.Last 90 Days : 12

Experience.Flight Crew.Type : 327

ASRS Report Number.Accession Number : 1098330

Human Factors : Situational Awareness

**Events**

Anomaly.Aircraft Equipment Problem : Less Severe

Anomaly.Conflict : Ground Conflict, Less Severe

Anomaly.Ground Incursion : Runway

Detector.Person : Flight Crew

Miss Distance.Horizontal : 1000

When Detected : Taxi

Result.Flight Crew : Became Reoriented

**Assessments**

Contributing Factors / Situations : Aircraft

Contributing Factors / Situations : Human Factors

Primary Problem : Ambiguous

**Narrative: 1**

I was taxiing in my 172 Skyhawk to the departure end of the active Runway 28 [at TRK]. There was clearly glider activity on the adjacent runway, as I had seen them taking off all morning and was paying attention to where they were headed. I was using an iPad with Foreflight as my primary navigation, supplemented with on-board GPS, and then chart pilotage. On taxi I noticed that my radio was very static-filled and scratchy. I was having a hard time hearing anything. My passenger noticed this as well, and asked me to turn down the radio (I declined). I thought that the problem with the radio was somebody else on the same

frequency with a stuck mike or some other problem with the local CTAF frequency.

I was in a hurry to takeoff, as the airport was already busy and I was concerned about density altitude, as it was forecast to be extremely hot. TRK is at about 6K MSL so it's high, and it was going to be hot. I was anxious and wanted to get out of there. I fueled up and taxied to the departure end of 28, and I crossed the intersecting runway where the gliders were operating without even stopping. I got a radio call from the tow plane on the runway as I crossed where he asked if I saw him. I responded with two clicks, as I was already past the center-line of Runway 1-19. The pilot of the glider made a radio call stating "I think he has his radio turned down." I responded with "I hear you, but transmissions are barely audible and broken."

I don't believe that the tow plane was moving yet, but they were about to begin takeoff roll. I realized what had happened at this point, and felt like this could have been a very close call. Nothing happened besides me scaring the glider and tow pilots, and then scaring myself, but there are a few factors here that contributed to this: 1.) I wasn't aware of the runway configurations, and I either ignored the signage or it wasn't very clear. I didn't know that I was crossing a runway (active or otherwise.) I was in a hurry, and stressed, but I still don't feel like the signage and markings were very clear. 2.) Using Foreflight on an iPad and a new Dual GPS unit; I had a new Scosche dual cigarette lighter charger that I purchased from [an aviation supply retail store] to power both the

iPad and the GPS unit. I had used this on the way down with no issues. But, once airborne, I noticed that the radio noise was not going away. I began to be concerned that I was having dual radio failure, as this was happening on both of my radios. I was concerned about having total communication loss. I made a call to Tower and they read me loud and clear, but I was still having a very difficult time hearing anything.

As I was troubleshooting this I unplugged the cigarette lighter charger. The noise ceased, and everything was OK. The charger was emitting frequencies that were reading my radio unlistenable. This was the number 1 problem in this entire situation, combined with poor situational awareness on my part, and being rushed. I was really surprised by this for two reasons: 1.) I had used this charger on the flight to TRK two days prior with no poor results. This was one of the reasons it took me a while to even test it. 2.) This charger was expensive and purchased because I thought it was shielded to prevent this kind of problem. I had heard of this problem happening with other cheap auto chargers, so I spent the 30 dollars on the better, aviation-specific charger.

This was the closest call I have ever had. It was scary and stupid, and I accept responsibility for the close call. I learned something here. That said, something needs to be done to help insure that these kinds of chargers don't interfere with radios and other in-flight instruments. This could have been much worse. As the iPad and other electronics move into the cockpit we need to make sure that they help, and

don't do harm. This is the future for sure (and I love Foreflight on the iPad; it's the best thing to happen in GA in a decade or more) but let's make sure that we can make this move forward safely.

**Synopsis**

C172 pilot reported communication difficulty that led to a runway incursion that he later traced to interference from a power splitter.

**APPENDIX L: Report that provides an instance of pilots being distracted by external influences**

**ACN: 1060026**

**Time / Day**

Date : 201301

Local Time Of Day : 1801-2400

**Place**

Locale Reference.Airport : HOU.Airport

State Reference : TX

Altitude.AGL.Single Value : 0

**Aircraft : 1**

Reference : X

ATC / Advisory.Tower : HOU

Make Model Name : Premier 1

Flight Plan : IFR

Flight Phase : Initial Climb

Route In Use : None

Airspace.Class B : HOU

**Aircraft : 2**

Reference : Y

ATC / Advisory.Tower : HOU

Make Model Name : Citation Excel (C560XL)

Flight Plan : IFR

Flight Phase : Taxi

Route In Use : None

**Aircraft : 3**

Reference : Z

ATC / Advisory.Tower : HOU

Aircraft Operator : Air Carrier

Make Model Name : Commercial Fixed Wing

Operating Under FAR Part : Part 121

Mission : Passenger

Flight Phase : Landing

**Aircraft : 4**

Reference : W

ATC / Advisory.Tower : HOU

Aircraft Operator : Air Carrier

Operating Under FAR Part : Part 121

Mission : Passenger

Flight Phase : Taxi

**Person**

Reference : 1

Location Of Person.Facility : HOU.Tower

Reporter Organization : Government

Function.Air Traffic Control : Local

Qualification.Air Traffic Control : Fully Certified

ASRS Report Number.Accession Number : 1060026

Human Factors : Situational Awareness

Human Factors : Confusion

Human Factors : Communication Breakdown

Communication Breakdown.Party1 : ATC

Communication Breakdown.Party2 : Flight Crew

**Events**

Anomaly.Conflict : Ground Conflict, Critical

Anomaly.Deviation - Procedural : Published Material / Policy

Anomaly.Deviation - Procedural : Clearance

Anomaly.Ground Incursion : Runway

Detector.Person : Air Traffic Control

Result.General : None Reported / Taken

**Assessments**

Contributing Factors / Situations : Aircraft

Contributing Factors / Situations : Human Factors

Primary Problem : Human Factors

**Narrative: 1**

North flow with Runway 22 active. All Runways in use makes operations complex because traffic is departing, landing and taxiing to/from all

quadrants of airport. Aircraft Z just landed Runway 30L, I scanned Runway 22, [and] then cleared Aircraft X for departure off of Runway 22. I line up Aircraft W on Runway 22 and clear Runway 30L when Supervisor yells, "what are you doing, you have someone crossing down here!" I look and see Aircraft Y cross the departure end of Runway 22 on Taxiway GOLF. My departure is beyond the safe point to cancel takeoff. The ASDE alarms. Aircraft Y was instructed to taxi to Runway 35 at G3 intersection for departure. This runway intersects Runway 22, but G3 is North of Runway 22 and Aircraft Y was not cleared, nor should he have crossed Runway 22. Aircraft Y read back the clearance to taxi to Runway 35 at G3. I am not sure of what to suggest. This was a pilot deviation. Ground and Local controllers scanned the runways, and the pilot read back the correct clearance. Because of the complexity of the traffic flow on this landing and departing configuration, extra caution is always taken when taxiing aircraft to and from the runways. Ground Control assigned the correct runway, and the aircraft read back the correct clearance. Ground observed the aircraft taxiing to the correct runway and Local Control scanned the departure runway and saw that it was clear before departing Aircraft X.

**Synopsis**

A HOU runway conflict occurred when a taxiing aircraft crossed an active runway without clearance.