RUNWAY SAFETY ALERTS:
HOW FAST CAN WE REACT TO THEM?

by Gerard van Es

On March 15 2011 an A320 (with callsign SWR 1326) was cleared for take-off on runway 16 of Zurich airport. The crew of SWR 1326 acknowledged this clearance and initiated their take-off roll. Another A320 (with callsign SWR 202W) on runway 28, also received clearance for take-off from the same controller. The crew of SWR 202W acknowledged this clearance and immediately initiated their take-off roll on runway 28. Runway 16 and runway 28 intersect each other about half way along runway 16 and about two-thirds of the way along runway 28. At the time the take-off clearance was being issued to SWR 202W, SWR 1326 had already started its take-off. During the take-off roll, the crew of SWR 202W noticed SWR 1326, which was coming from the right on runway 16, and immediately aborted their take-off. A few seconds later, the air traffic control officer gave the crew of SWR 202W the order to immediately stop their take-off. SWR 202W came to a standstill on the runway just before the intersection with runway 16. The crew of SWR 1326 had not noticed the incident and continued their flight to their destination. Well before the crew of SWR 202W decided to reject their take-off, the air traffic control officer received an alert from the runway Runway Incursion Monitoring and Conflict Alert System (RIMCAS) that was operational at Zurich airport. It took nine seconds for the air traffic control officer to give the stop instruction to SWR 202W after the alert was generated. At that time the crew of SWR 202W already rejected the take-off so this instruction had no effect.

The air traffic control officer was surprised by the runway incursion alert and believed in the first instant that it was a "false alarm with a vehicle"[1]. The SWR 1326 was no longer present in the controller's mental plan at this point in time. The air traffic control officer checked whether a vehicle was close to the runways or whether a landing aircraft was on runway 16. The controller then finally realised that two aircraft were simultaneously taking off on runway 16 and runway 28.

Many airports have runway safety systems in order to avoid collisions due to a runway incursion. Such systems have a sensing/surveillance part that determines the position, direction and speed of aircraft and ground vehicles; a safety logic part which consists of rules and algorithms to interpret these data; and a human interface in which the information is passed on to the aircraft traffic controller or pilot. All systems currently in operation at airports are so-called tower-based systems in which the information from the runway safety system is passed on to the controller only. After receiving an alert from the runway safety system the controller has to make an evaluation of the situation and based on that outcome make a decision of the course of action (e.g. give instructions to the flight crew). This process of evaluating and decision making can take a lot of time as illustrated in the example at the beginning. This single example however does not give us a clear picture on what typical response times are (the response time is the time span between the onset of the alert and the response of the controller). There are a number of variables that influence the response time like age of the controller, experience, workload, environmental conditions (e.g. visibility, light conditions), complexity of the runway layout and trust in the runway safety system. This last variable is influenced by the rate of false and nuisance alerts generated by the runway safety system.

On top of the response time there is also the duration of the controller response which is the total time of the verbal communication with an aircraft or ground vehicle (e.g. giving a directive warning). Human-in-the-

1- Runway safety systems like RIMCAS may provide false alerts if the quality of the surveillance data used by such systems is not optimal. In addition to false alerts, nuisance alerts are generated by runway safety systems. Finally untimely alerts can also occur due to the safety logic design. A high rate of false, nuisance, or untimely alerts may hamper the effectiveness of any warning system. It can change the user's attitude and belief about the warning system. As a result they may lose confidence in the system.

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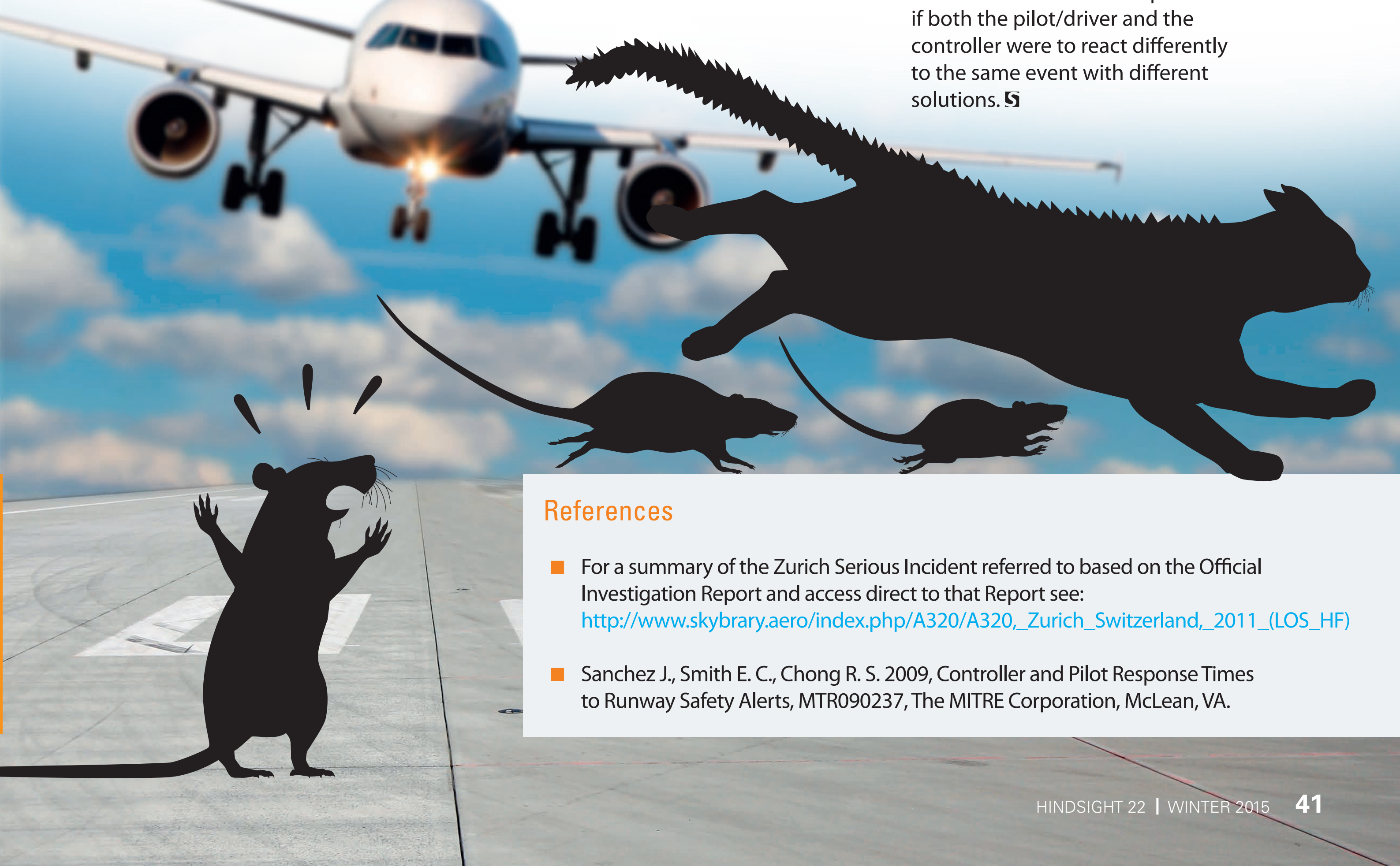
loop simulations conducted by the MITRE Corporation give us some idea of what the typical response times and response durations can be. These experiments were conducted using a tower simulator and a flight deck simulator. A group of tower controllers was asked to work several scenarios. In some of these scenarios a runway incursion was simulated and alerts were generated by a runway safety system. Of course such an experiment can never fully simulate the real world as the participants were more or less prepared for an alert to occur. Nevertheless the results of the MITRE experiments give us an idea of what you can expect in terms the typical delays of getting an important message to a flight crew or a vehicle driver. The MITRE experiments showed that the mean response time of the controller to an alert was 4.6 seconds with a maximum of 8.1 seconds. The mean response duration was 2.3 seconds with a maximum of 5.3 seconds. By simply taking the averages together, an average time from the alert to instructing the pilots takes about 6.9 seconds with a maximum of 13.4 seconds! These results illustrate that the time the air traffic controller officer in the incident example took (9 seconds) is nothing out of the ordinary. But the story does not stop here because now the pilot or vehicle driver must take action. Let's focus on the pilots a bit more. Just like the controller, the pilot needs some time to respond and act to the instruction given by the controller. However, the pilot just needs to react most of the time whereas the controller needs to assess if the alert is true or not and decide on the best option to resolve any issue. Of course this takes more time for the controller than for the pilot. The experiments by MITRE showed that the time span between the onset of the controller's instruction to the pilot and the start of the action by the pilot can take up to 5.3 seconds with an average of 2.3 seconds. If we assume that the controller has given a stop instruction, the pilot still has to initiate the rejected take-off procedure. Once it has been started, it still takes time for all the stopping devices available to become effective. For instance it can take about 2 seconds before the brakes are fully effective and the lift dumpers fully deployed (if installed). If it is a jet aircraft, and thrust reversers are available, it can take 4 to 8 seconds to get full reverse thrust after reverser deployment. Meanwhile the aircraft is using up runway distance and may be getting closer to the conflicting aircraft or vehicle.

Although runway safety systems can be very effective in avoiding runway collisions, there are cases in which these systems are less effective due to the long time it takes from the activation of the alert to the actual action taken by the pilot or vehicle driver. Runway safety alerts could be send directly to the pilot or vehicle driver, but then they would still need to assess the situation and make a decision. This would take additional time (although less if the air traffic controller was in the loop). Such additional decision time could be avoided by using directive alerts (or advice as in the case of TCAS 2) that tell the pilot or vehicle driver what action they should take, but this would require that the users have a high level of trust in the system. But taking the controller out of the loop could also introduce new problems if both the pilot/driver and the controller were to react differently to the same event with different solutions.



References

- For a summary of the Zurich Serious Incident referred to based on the Official Investigation Report and access direct to that Report see: http://www.skybrary.aero/index.php/A320/A320,_Zurich_Switzerland,_2011_(LOS_HF)
- Sanchez J., Smith E. C., Chong R. S. 2009, Controller and Pilot Response Times to Runway Safety Alerts, MTR090237, The MITRE Corporation, McLean, VA.