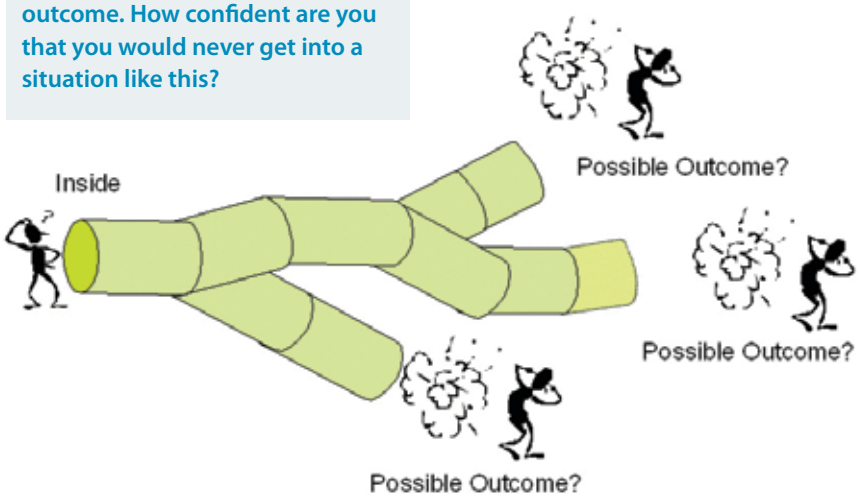
An ATC-induced runway incursion

Editorial note: This situational example is not a real occurrence and neither is it intended to be a full description. It has been created to allow a focus on operational safety and human performance aspects.

THE FACTS

Read the story as it develops, position yourself in the context without knowing the actual outcome. How confident are you that you would never get into a situation like this?



You're a student controller, well advanced in your on-the-job training in the tower of an international airport. Today there are low clouds, with an overcast base that is lower than the tower work floor, so low visibility procedures are in force. Your instructor is also the tower supervisor on this shift.

You're responsible for departures from one runway and arrivals on another runway. The runway axis of the landing runway crosses that of the departure runway, so you have to time the departures to take place once a landing aircraft is safely on the ground but before the next aircraft on final reaches a specified distance from touchdown.

Your "tools" include a traffic situation display on which you can see the aircraft on final, with their distance from touchdown displayed numerically in the labels. You also have a ground radar display, situated to your side, on which you can see aircraft and vehicles on the manoeuvring area. The ground radar shows radar returns only, there are no labels for the targets.

On the ground radar you observe an aircraft decelerating after landing and you clear an aircraft for take-off on the other runway. At the same time you hear an airport vehicle asking for permission to cross the take-off runway with a towed aircraft. This call is received at the position of the assistant controller, which is to your right, and is done on a dedicated frequency for vehicle ground traffic. You tell the assistant that the vehicle and tow will have to wait, and the assistant relays the instruction to wait to the driver of the vehicle. The instruction is acknowledged correctly by the driver.

After the departing aircraft is airborne, which you verify by looking at your traffic situation display, you tell the assistant that she can give the vehicle and tow permission to cross the runway. She informed you earlier that the vehicle and tow are on their way to a platform on the other side of the runway, so you select the appropriate stop bar control button and you switch off the stop bar.

However, there is no indication on your stop bar control panel that anything has changed, and you realise immediately that the configuration of the control panel is not correct.

ATC-induced runway incursion (cont'd)

What would you do?

Rather than reconfiguring the control panel you ask a colleague at another working position in the tower to push the button to switch off the stop bar, which he does. This colleague subsequently takes the initiative to correctly reconfigure the stop bar control panel, so now you have control of the buttons.

You turn your attention back to your traffic. A Boeing 767 checks in at the holding point and reports "ready for departure". Since you know that the vehicle and tow are crossing the runway, you clear the B767 to "line up and wait". The assistant asks you to switch off the stop bar again, for apparently the vehicle driver has reported still being in front of a row of red lights.

What would you think?

This increases the doubt you already have about your understanding of the newly introduced stop bar control panel. At the intersection where the vehicle and tow want to cross there are stop bars on either side of the runway, which can be switched off individually with separate buttons that are marked "west" and "east". But since the runway is 06/24 it always confuses you to think which side of the intersection is west, and which one is east.

What would your next action be?

Your instructor, who was engaged in a discussion with the other controller about the correct configuration of the stop bar control panel, comes up and you propose to resolve the stop bar issue by pushing both the "west" and the "east" buttons. The instructor agrees with this solution, so you push both buttons and turn your attention to your aircraft again.

The call from the B767 a little later that they are aborting take-off because they have a towed aircraft crossing in front of them takes you completely by surprise.

Meanwhile you notice that there is a suitable gap developing in the sequence for the landing runway, so you mentally mark that as an opportunity to let the B767 depart. According to your estimate the runway crossing should also be completed by the time the gap occurs, so all you need to do is wait for confirmation from your assistant that the departure runway is clear again.

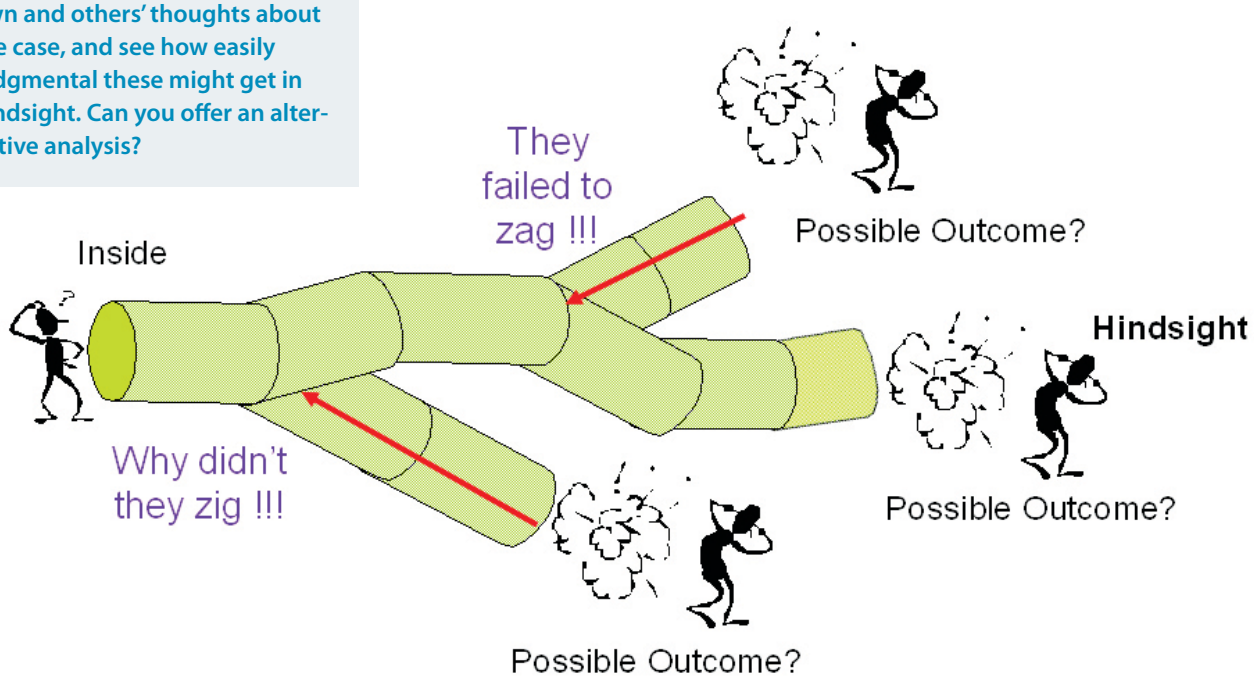
You monitor the landing of the aircraft that is at the front end of the gap, and you respond to a call from the next landing aircraft when it reports on the tower frequency. While doing this you hear a call from the driver of the vehicle with the tow on the other frequency at the working position of your assistant. You assume that this call was to report "runway vacated" after completion of the crossing, but you can't get confirmation from your assistant for she is not looking in your direction.

What would you do?

You look at the screen of the ground radar for the position of the vehicle and tow, and you see it clear of the runway at the other side of the intersection. The next landing aircraft is almost at the minimum distance from touchdown at which you are allowed to let an aircraft depart. You're convinced that everything is as it should be, so you clear the B767 for take-off. The call from the B767 a little later that they are aborting take-off because they have a towed aircraft crossing in front of them takes you completely by surprise.

DATA, DISCUSSION AND HUMAN FACTORS

Now read the story knowing the actual outcome. Reflect on your own and others' thoughts about the case, and see how easily judgmental these might get in hindsight. Can you offer an alternative analysis?



FACTORS THAT WERE IDENTIFIED IN THE INVESTIGATION OF THIS OCCURRENCE INCLUDED:

Human machine interface (HMI) issues.

The assistant controller did not have a ground radar display at her working position (liveware-hardware). She was unable to verify the position of the vehicle and tow when they contacted her to cross the runway. There were displays to the left and to the right of her working position; the one on the left was showing a picture from the terminal radar (for the benefit of the student controller), the one on the right was showing an off-centred ground radar picture (for the benefit of another controller) on which the intersection where the vehicle and tow were located could not be seen. When the student controller tried to get confirmation from her that the crossing had been completed, she was turned towards the screen on her right in order to try and monitor the progress of the vehicle and tow.

This may explain why she didn't hear the student controller issue the take-off clearance to the B767 before she had confirmed that the runway was vacated by the vehicle and tow.

Another HMI issue (liveware - hardware) related to the stop bar control panel. The stop bars at the intersection where the vehicle and tow were crossing had been installed a few months before the occurrence. The buttons by which those stop bars were operated could not be incorporated into the existing panel (with a geographical layout) from which the other stop bars are controlled. It was therefore decided to add a new panel (with a tabular layout) to the side of the existing panel; it was also decided that there should be separate buttons to independently control the stop bars on either side of the intersection.

ATC-induced runway incursion (cont'd)

A further HMI issue (liveware - software) was found in the labels of the buttons on the new stop bar control panel. The stop bars were at either side of an intersection of runway 06/24, which logically means a stop bar on the north side and one on the south side of the runway. The labels on the panel however were "west" for the stop bar on the north side, and "east" for the stop bar on the south side of the runway.

This may have contributed to the confusion of the student controller about which stop bar was the correct one to switch off in order to allow the vehicle and tow to cross the runway.

Training issues

When the new stop bars and the associated control panel were installed, the controllers (including student controllers) were informed about this by means of a "training bulletin", i.e. a written message in which the new items were announced. There was no further introduction or training on how to operate the new panel. The day of the occurrence, with low visibility procedures in force, was in fact the first time for the student controller (and also for his instructor) that the new panel had to be used.

This may explain why the student controller doubted his own understanding of the working of the new panel rather than doubting the information from the assistant about the position of the vehicle and tow.

Procedural issues. When the vehicle called the tower for permission to cross the runway with a towed aircraft, the driver only mentioned the name of the intersection where he wanted to cross. He did not mention his actual position or the direction in which he wanted to cross. The existing R/T procedures didn't require him to mention either of those items, and this had never caused problems before at the airport for at all other intersections the stop bars on both sides were operated with one button on the control panel in the tower.

The call that the student controller mistook as the "runway vacated" message was in fact a call from the vehicle driver to say that the stop bar was finally off and that they had now begun their runway crossing.

The tow movement from the platform during low visibility procedures should have been coordinated between apron control (i.e. the airport authority) and the ground controller (i.e. ATC), but this had not been done at the time of the occurrence.

Recency and proficiency issues. The assistant controller had only returned to operational work in the tower shortly before the day of the occurrence. For the better part of the preceding year she had been a student controller in the approach control department at the same airport, but unfortunately she couldn't complete the training so it was decided to retain her as an assistant controller. She had received only the minimum number of shifts to re-familiarise herself with the work in the tower, and was unaware that during her absence a tunnel under the departure runway had been constructed for vehicles and tow trucks to move to and from the platform without having to cross the runway.

This may explain why she was convinced that the vehicle and tow wanted to cross the runway towards the platform, whereas in fact they were coming from the platform (i.e. the other side of the runway): to her it was logical that a vehicle that hadn't contacted her before could only be on the "terminal building" side of the runway.

On-the-job training (OJT) issues. The fact that the instructor was also the tower supervisor had a bearing on the occurrence. In his role as supervisor, the instructor was occupied in a justifiable discussion with another controller, which took place on the opposite side of the work floor from where the student was sitting. He had briefly moved closer to the student to approve the pushing of both stop bar buttons, but he subsequently moved back to the other side of the tower again.

This may explain why the instructor didn't hear the student issue the take-off clearance before the runway had been confirmed vacated by the assistant.

HERA KEY WORD ANALYSIS

Note: This section is offered as an alternative way of analysing the occurrence. Key words from the Human Error in ATM (HERA) methodology are presented with a brief explanation of how they relate to the occurrence.

Misperception
The student controller switched off the stop bar on the side of the runway where he thought the vehicle and tow were positioned. When the vehicle reported still having a lit stop bar in front, the student controller took that as an indication that his understanding of the new stop bar panel was inadequate, rather than as an indication that the vehicle and tow might be at a position other than that expected.

Expectation bias (1)
The assistant controller expected that vehicles asking to cross the runway had to be on the "terminal building" side upon first contact. She was so convinced of this that she passed on the information to the student controller without confirming the position of the vehicle and tow.

Expectation bias (2)
The student controller was waiting for confirmation that the vehicle and tow had completed the runway crossing. When he heard a call on the frequency for vehicle traffic at the position of the assistant controller, he believed that this was the report that the runway had been vacated even though he couldn't get confirmation from the assistant.

Expectation bias (3)
The student controller looked at the ground radar display to verify that the vehicle and tow had crossed the runway, and he identified them at a position on the platform side of the runway, just where he'd expect them to be after crossing from the other side. This was the confirmation he was looking for so he believed that the runway had been vacated by the vehicle and tow.

Fixation
The student controller was eager to execute his plan to let the B767 depart in the particular gap that he had targeted in the sequence for the landing runway. He therefore didn't consider the option to wait for another gap in order to ascertain that the runway crossing had been completed.

Contextual conditions (in no particular order)

- Low visibility procedures
- Inaccurate procedures (i.e. the vehicle traffic R/T for requesting to cross a runway)
- OJT
- Knowledge for position (assistant not aware of the tunnel under the runway)
- New/recent changes
- Lack of TRM (see below)
- HMI issues
- No equipment (no ground radar display at assistant working position)
- Mode confusion (stop bar control panel configuration)
- Distraction (supervisor/ instructor)
- Adherence to rules by others (no coordination by airport authority about the tow movement)

The day of the occurrence, with low visibility procedures in force, was in fact the first time for the student controller (and also for his instructor) that the new panel had to be used.

ATC-induced runway incursion (cont'd)

Prevention strategies and lines of defence

If the air navigation services provider (ANSP) had introduced a team resource management (TRM) programme, this could have helped the tower crew to function more as a team than as individuals with a narrow focus. Expressing doubts about (the understanding of how to operate) equipment, asking an instructor for help, and asking questions for clarification are things that are only done if the environment for it is right. TRM training makes it easier to establish such an environment.

The ANSP should not require OJT instructors to perform other duties while giving instruction, and have a formal programme for reintegrating operational staff on the work floor after a prolonged absence.

If a safety assessment had been conducted before introducing the stop bars at the intersection concerned, it is likely that the issues with the HMI and the procedures would have been identified and mitigated.

At the time of the occurrence such a safety assessment was not formally required, but as of 2006 ICAO Annex 11 contains a provision that mandates it.

At individual level controllers should be aware of the dangers of assumption.

The assistant controller assumed that the vehicle and tow were moving towards the platform although this had not been confirmed or verified in any way.

The student controller was eager to give take-off clearance to the B767 in order not to "waste" the gap in the landing sequence, so he really wanted to hear that the runway had been vacated. When he heard a transmission on the frequency for vehicle traffic at the working position of the assistant, he assumed it was the expected message that the runway was vacated.

In both instances a simple question for clarification would have resulted in certainty about the direction in which the vehicle and tow were moving ("What is your position?") and about the status of the runway crossing ("Confirm the vehicle and tow are off the runway?").

The student controller could have used his ground radar picture to determine the position of the vehicle and tow before letting them cross the runway.

As stationary objects without labels however such targets were not easy to spot on the ground radar screen. With multilateration technology and labels for vehicles and aircraft the newer generation of ground radar displays provides an improved and comprehensive overview nowadays. Still, controllers must have the discipline to look at the picture!

A further line of defence is to inform the pilots of an aircraft that is lining up to wait on a runway that a runway crossing is in progress (or that the runway is occupied by a vehicle) when appropriate.

Whether or not this would have prevented the occurrence from happening is an academic question. In addition to low clouds there was limited visibility at the time, so it's hard to determine whether the pilots would have been able to see the vehicle and tow from the beginning of the runway. The fact is though that in their take-off roll the pilots did see the tow aircraft crossing the runway in front of them, so they immediately aborted their take-off and brought the aircraft to a stop well before the intersection where the crossing took place.

The strategy mentioned above is also useful in case the vehicle(s) is/are on the same frequency as the aircraft (another line of defence), for pilots may not always be able to correctly interpret everything they hear on the frequency. Never assume that pilots "have the picture" just because communications are on a common frequency!

KEY POINTS

The consequences of a change in the airport infrastructure (new stop bars at an intersection) for existing procedures (R/T for vehicles) and for modifications to equipment in the tower (stop bar control panel) had not been fully understood at the time the change was implemented. Consequently a breakdown in the team work on the tower work floor was possible, which resulted in a situation where an aircraft was cleared for take-off when a vehicle with a towed aircraft was cleared to cross the runway at the same time.

This scenario highlights the importance of:

- conducting a safety assessment before changes in (airport) infrastructure, equipment or procedures are effected;
- team resource management (TRM) principles;
- not assigning additional duties to OJT instructors;
- avoiding assumptions.