Runway collisions: a problem solved?

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The importance of reducing the risks of runway incursions is acknowledged throughout the aviation community.

Traffic conflicts on the runway pose a major threat to the safety of flights during takeoff and landing, with current EUROCONTROL statistics showing over 600 runway incursions each year in the European Civil Aviation Conference region alone. There have been several initiatives in recent years, which primarily address the problem of runway conflict by providing enhanced situational awareness in the air traffic control (ATC) room. However, this mechanism requires the ATC officer to relay advice to the concerned traffic, resulting in a significant delay from when the conflict is detected to when an appropriate evasive manoeuvre is taken.

The University of Malta has successfully adopted a reactive methodology to mitigating runway conflicts. Through the use of traffic surveillance and the analysis of the scenario dynamics and kinematics, an algorithm has been designed capable of pre-empting conditions which could develop into hazardous situations. Although this reactive system does not protect against the violation of clearances, the system can mitigate the risk of collision and fundamentally reduce the hazard associated with runway incursions. The system makes use of the emerging technology of automatic dependent surveillance-broadcast (ADS-B) where each aircraft broadcasts positional and velocity information to all other aircraft in the vicinity. This process enables the system to build a virtual map of all surrounding movement. When the aircraft is manoeuvring on the runway surface, any incorrect presence of another aircraft will put the system into an alert state. The use of ADS-B makes it necessary for each entity operating on the aerodrome to be equipped with the relevant instrumentation to be detectable by the ADS-B receiver. A detection algorithm based on ADS-B technologies could reduce the number of conflicts by a factor of five.

Aural alerts recommended

When the system has successfully detected a conflict, there are several approaches that could be adopted for cockpit alerting. The most fundamental requirement when introducing new alerts is that the new functionality does not conflict with existing systems. As the landing and takeoff phases of flight already place a high demand on visual resources, it is advised that an aural alert without the use of a visual display be implemented for runway conflict alerting.

A second design challenge is to ensure that the response to an alert occurs in a timely manner. In order to achieve this goal, the alert must be detected by the crew and provide a clear indication of the required response. Typically, an alert informs the operator, in this case the pilot, of a problem and the pilot is required to respond appropriately. However, this process can lead to variable responses because of the limited time available for decision making. The standard operating procedures normally provide a means of support in determining the correct course of action in an emergency situation. However, the nature of the alert itself can also enhance this decision-making process. The simplest form of an alert is a signal detector which identifies that a parameter has been exceeded and informs the crew, but more complex systems of alerting aim to increase response time by simplifying

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the cognitive response required by the pilot. For example, in a hazard resolution system such as a runway conflict, the system would provide an alert which incorporates a solution to resolving the conflict.

Promising early results
The Runway Collision Avoidance Function (RCAF) developed by the University of Malta aims to address these challenges by providing aural resolution advisories direct to the flight crew. In collaboration with Cranfield University, and under the umbrella of the European Union FLYSAFE project (www.eu-flysafe.org), the RCAF aural advisories were evaluated against a baseline system which merely informed the crew of a runway incursion. The aims of the evaluation were to establish the:

- validity, effectiveness and acceptance of the alerting philosophy on the flight deck from a human factors perspective;
- pilot reaction to the functional behaviour of the system in different operating conditions, and;
- strengths and weaknesses of the alerting technique and alerting system.

The results of the evaluation were extremely promising, with sufficient evidence to indicate that the RCAF resolution advisories would be acceptable on the flight deck, providing the crew with added confidence in performing a takeoff or landing manoeuvre, particularly in poor weather conditions and low visibility.

And now...?
The potential benefits of the RCAF to regional and business aircraft, as well as the general aviation community, should be explored. Further testing with potential users is vital to ensure that this new strategy for resolving runway conflicts is compatible with existing task requirements in the cockpit.