Merging and Spacing Tools

Singapore is exploring ways to handle traffic more efficiently as air traffic continues to increase rapidly in the Asia Pacific. MITRE recently supported that goal with research on decision support tools for more efficiently merging and spacing aircraft on their landing approach.

Reducing Excess Spacing

In one project, sponsored by the Civil Aviation Authority of Singapore (CAAS), MITRE researchers adapted a United States (U.S.) air traffic control tool—Automated Terminal Proximity Alert (ATPA)—to study efficiency gains it might provide to Singapore's air traffic operations.

In the U.S., ATPA is available to air traffic controllers to help them maintain a safe distance between aircraft as they approach an airport for landing.

There are different weight categories for aircraft, depending on how much wake turbulence they produce. To keep the wake of the leading aircraft from disturbing the trailing aircraft, there must be safe separation between the two aircraft. That distance differs depending on the weight classes of the two aircraft.

To help air traffic controllers track the required separation distances and minimize excess spacing between aircraft pairs (see Figure 1), the Federal Aviation Administration (FAA) implemented ATPA. That tool automatically calculates the required separation for pairs of aircraft approaching the runway—based on their weight categories—and depicts that distance as a cone-shaped image on the controller's radar display (see Figure 2).

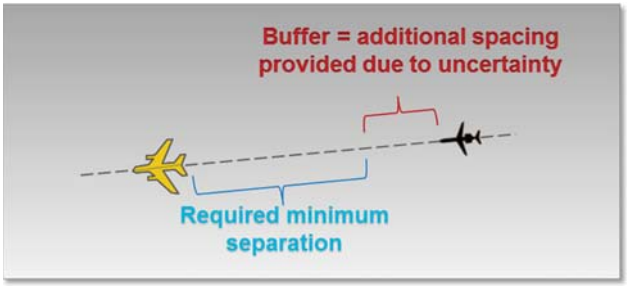

Figure 1. Excess Spacing Buffer

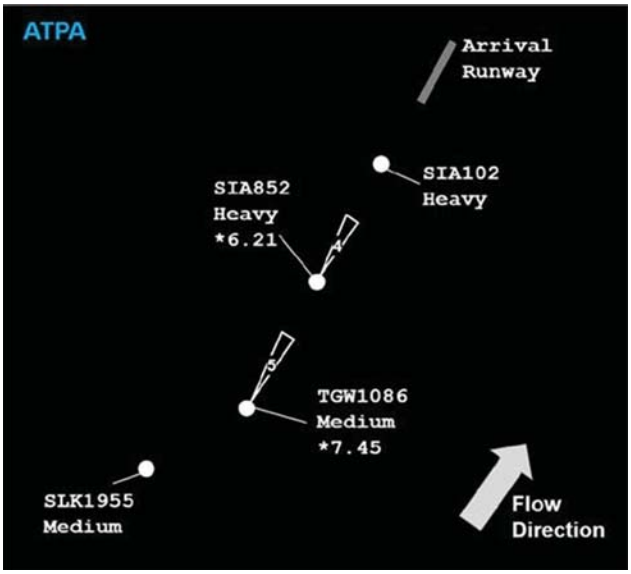

Figure 2. ATPA Example

By having that image, controllers can better keep the aircraft as close as possible to one another—for the sake of efficiency—but far enough apart to avoid wake turbulence.

Adapting the Tool for Singapore

In Singapore, the sequence in which flights are to land is set at a significance distance—40 nautical miles or more—from the airport, and controllers work to adhere to that sequence to enhance efficiency. To support adherence to these schedules, MITRE researchers created Enhanced ATPA (E-ATPA). In this tool, the cones showing the required separation distances between aircraft show up on controllers' displays much farther out from the airport, which is an enhancement to help controllers better maximize throughput.

When MITRE brought controllers to its Singapore-based laboratory to test E-ATPA's effectiveness in a simulated environment, the results were promising.

Using E-ATPA, controllers were more confident in putting arrivals closer together, while still maintaining safe separation between the leading and trailing aircraft. This tighter spacing translates into an estimated two additional arrivals per hour.

Merging Aircraft Efficiently

In addition to exploring tools to improve the spacing between aircraft on a single landing approach flight path, MITRE researchers saw an opportunity to provide automated support to Singaporean controllers handling the airspace farther from the airport—where aircraft are just beginning their descent and are not yet on a single path.

Flights from different directions must merge as they get closer to the airport so that they can land in an organized and safe sequence. But the flight paths that these aircraft follow differ markedly. While some are fairly direct, others are curved or include dogleg turns. That can make it difficult for the controller to tell which aircraft is closer to the merge point (see Figure 3).

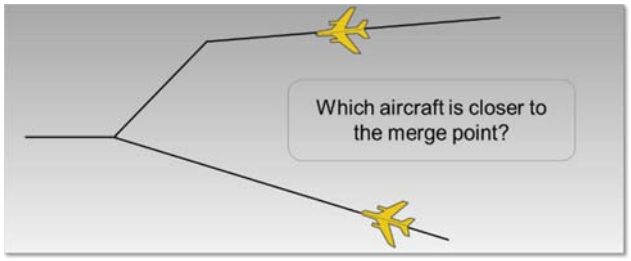

Figure 3. Illustration of the Difficulty in Predicting the Relative Position of Aircraft on Merging Paths

MITRE researchers took on the challenge of creating a tool that would help controllers do that, while also enabling them to keep the aircraft on their assigned paths and avoid inefficient reroutes.

To achieve these goals, MITRE created the Relative Position Indicator (RPI), a prototype capability that builds upon facets of an existing MITRE-developed tool used by U.S. controllers who manage flights arriving to converging or intersecting runways.

The prototype calculates the distance of the merging flights' paths and projects them as "ghost tracks" on a central track on the controller's display. This allows controllers to quickly see which flight path is longer and which flights they may need to speed up or slow down to prevent a conflict as the aircraft merge. During testing, controllers reported that the ghost tracks were beneficial to their decision-making process.

CAAS, Singapore's air navigation service provider, is now considering integrating aspects of E-ATPA and RPI into the country's operational air traffic management system.