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Brad Cornell, senior engineer 787 Flight Crew Operations, foreground, in the 787 rapid prototyping flight deck simulator in Seattle. Behind him, from left, are Graham Whitehouse from flight deck and Gordon Sandell from avionics simulating a tailored arrival that helps to validate design requirements.  
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# Touchdown

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Commercial Airplanes and Phantom Works engineers are developing a technology for smooth – and tailored – airplane landings at congested airports that promises considerable cost savings for the airlines.  
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By DARYL STEPHENSON

It doesn't take a pilot or an air traffic controller to know that moving arriving aircraft efficiently through busy terminal airspace can be difficult.

As traffic builds, controllers must often direct aircraft away from an airport and place them in holding patterns until they are ready to bring them in for landing. As a result, these aircraft burn more fuel, flights get behind schedule and noise increases.

In this setting, aircraft come in without any advance planning of their arrival paths. Their approaches fit a vectored, step-down pattern, as pilots and controllers engage in back-and-forth voice communication to make course corrections and ensure proper descent. The aircrews are unable to take advantage of built-in technologies onboard their aircraft that are designed to provide for an automated, smooth approach.

Boeing engineers from Phantom Works and Commercial Airplanes, working with government agencies, airlines, air navigation service providers and other aerospace companies, have come up with a better way through an innovative advanced Air Traffic Management concept called Tailored Arrivals.

The Tailored Arrivals concept combines new automation technologies in air traffic control facilities on the ground with data link technologies in aircraft to effectively plan approaches in advance and provide a more efficient routing of the aircraft to touchdown. Recent trials of Tailored Arrivals have involved the use of the Federal Aviation Administration's Ocean 21 automation system developed by Lockheed Martin and Boeing aircraft equipped with the FANS-1/A air/ground integrated data-link system. The concept also can work with Airbus aircraft equipped with FANS-1/A.

The FANS-1/A data link establishes a four-dimensional flight profile (three spatial dimensions plus time) between an air traffic control facility and the flight deck of an approaching aircraft when it's ready to begin its descent, about 140 miles away from final destination.

The flight crew uses the auto-load function to transfer the profile into the aircraft's flight management computer (FMS) for review. Once the crew accepts the profile and confirms that it will be flown, the FMS flies the given trajectory to touchdown with considerable accuracy. Rather than the vectored, step-down approach, the profile is an efficient, predictable, continuous descent – with the aircraft's engines operating at near idle from cruise altitude to near touchdown.

There's little need for voice communication between the aircrew and controllers as the data link system transmits information such as aircraft position, intent and weather to the ground air traffic control facility. The approach reduces fuel consumption, emissions and noise as it eases the workloads of pilots and controllers.

"One of the main themes of the Tailored Arrivals project is to get more value out of the existing capability in the airplane and the new emerging capabilities in ground systems," says Rob Mead, Phantom Works lead engineer for advanced ATM air/

ground communications. "We're trying to get to a point in which the airplane can fly the way it was designed to be flown (with full use of built-in automation), with a data link to ground tools that now have the capability to run the Tailored Arrivals procedure. We think this can improve the efficiency of flight operations without a lot of new investment by airlines or airports."

Trials of Tailored Arrivals (in Australia, The Netherlands and most recently at San Francisco International Airport) are indicating that the concept can help aircraft save significant amounts of fuel as they approach an airport for landing. The fuel savings range from about 400 pounds or 60 gallons to about 800 pounds or 120 gallons per flight.

"When fully implemented, Tailored Arrivals could save airlines \$100,000 per year in fuel costs per aircraft for flights into major airports," says Mead. "The real benefits would be in congested airspace operations, which would depend on the characteristics of each air space."

The Tailored Arrivals trials, which have been going on for more than two years, are also showing that the concept can increase airspace capacity and maintain airline schedule integrity. The trials have taken place in three parts of the world to ensure "that we have a global package that is flexible enough to meet regional needs," Mead says. The first set of trials was in 2004 at airports in Sydney and Melbourne, Australia.

The most recent set of trials at San Francisco included 17 flights with United Airlines 777-200 airplanes in mid-2006. Boeing conducted the trials under a joint program with the National Aeronautics and Space Administration's Ames Research Center at Moffet Field in California.

The trials' diverse set of environments, technologies and partners is bringing the Tailored Arrivals concept closer to reality, says Brad Cornell, BCA senior engineer, 787 Flight Crew Operations, who led the 2004 trials in Australia. "We're adding complexity, we're adding robustness, and we're adding to our portfolio of partners who can understand and advance the technology," he says. "We're trying to accelerate fundamental change to open the market for future growth of commercial aviation. And we'll reach out to anyone who will help us in that mission."

Mead says that demonstrating how Tailored Arrivals work in a congested environment is the next step as part of a follow-up program with NASA. "What we would like to do is to get into a more congested area, preferably a landlocked area, so that we can exercise more of the domestic data link and upgrade the ground automation to handle congested operations," he says.

"From a technology readiness standpoint, the technology is ready," Mead says. "The savings get very big very quickly for the airlines." ■



Engineer Kevin Elmer, a member of the Tailored Arrivals team in Huntington Beach, Calif.