Enabling Cockpit-Based Self-Separation

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The goals of this effort were to design and develop prototypes of flight deck tools to support airborne management of separation and to evaluate the feasibility of shifting flight deck and ATC roles and responsibilities relating to the management of separation. The concept of Free Flight introduces many challenges for aviation operations in the air and on the ground. Of considerable concern is the plan to move from centralized control and responsibility for aircraft separation to decentralized control and distributed responsibility. Data from capacity studies suggest that the National Airspace System (NAS) will reach its capacity limits with the current centralized Air Traffic Control (ATC) system within the next 2 decades.

Based on these predictions, research on distributed air-ground concepts has been undertaken to identify and develop air-ground concepts in ensure that free-flight operations are implemented successfully. The underlying concept evaluated in this effort was based on three principles: (1) Aircraft should always broadcast intent information in the form of current flight plans; (2) All flight plans should be deconflicted to the maximum extent possible (in this case out to a range of 120 NM); and (3) The interface for flight-path re-planning tools should be graphical and impose low workload.

A full mission air-ground simulation was conducted in the Crew Vehicle Systems Research Facility located at Ames in support of this effort. Its goal was to evaluate the effect of advanced displays with intent information (e.g., 4D flight plans) on flight crew and ATC performance during limited free-flight operations. To assess the value of 4D intent information, flight crews performed real time, strategic, flight path re-planning with and without access to graphically presented 3D flight plan information about surrounding traffic during en route operations. To support the re-planning task flight crews used an enhanced cockpit situation display (CSD) that depicted surrounding traffic, a dynamic 4D predictor symbology, and tools which alerted the crew to impending losses of separation (see Figure 1). The conflict alert tool was color coded (blue, white, and green) to reflect aircraft and portions of flight plans that were above, at, or below Ownship altitude. The CSD also contained a graphical route assessment and replanning tool used to develop alternative (de-conflicted) flight plans (see Figure 2). Once developed, modified flight plans were submitted electronically for approval and automatically loaded into the autopilot and data linked to all surrounding traffic once approved. The study also examined two levels of ATC authority: (1) Limited Authority - - ATC intervened only when a loss of separation was imminent and (2) Full Authority - - ATC ran the sector as they would normally.

The results suggest that flight crews with advanced 4D flight plan information can perform strategic self-separation during operations in densely populated traffic environments. And, when ATC remains in the information and approval loop strategic self-separation performed by flight crews is not disruptive to normal ATC sector operations. The results also showed that crews with access to 4D flight plan information were more efficient, made smaller deviations for traffic and fewer total flight plan modifications, and experienced lower workload. Crew evaluations of 3D and 4D traffic information, display de-clutter features and the advanced flight re-planning tools were very positive, although the input devices (knobs/dials or touch pads) were not as highly rated as the display itself.