2020 Foresight—a Systems-engineering Approach to Assessing the Safety of the SESAR Operational Concept

Derek Fowler, Eric Perrin, and Ron Pierce

This article explains why a new approach is needed for the safety assessment of the major operational and technology changes that are planned for introduction into European ATM up to 2020 and beyond. This approach has to satisfy two conditions: first, it has to be much broader than that traditionally followed in ATM in that it must address the positive contribution that a fully functioning ATM service makes to aviation safety and not just consider the negative effects that failures within the ATM system might have on the risk of an accident. Secondly, rather than rely simply on current, process-based safety-assessments, it must be based on a framework which, in accordance with European safety regulatory requirements, requires that “correct and complete arguments be established to demonstrate that the overall ATM System, as well as constituent parts, are (and will remain) tolerably safe”. The article presents the theoretical basis for satisfying these two conditions—it explains from first principles how current techniques such as Fault Tree Analysis can be adapted to model ATM’s positive, as well as negative, contribution to aviation safety, and describes how a rigorous safety argument can be derived from sound systems-engineering principles and be used to drive the whole safety assessment/assurance process. The article also gives an overview of how these principles were developed for application to the safety assessment of ATM development projects within the scope of SESAR—the Single European Skies ATM Research programme, equivalent to the US NextGen programme. This approach has already been applied by EUROCONTROL to a number of safety assessments including enabling projects for SESAR.

Embedded Statistical Analysis and Selection Procedures in Air Traffic Simulations

Kirk C. Benson, Amy R. Pritchett, and David Goldsman

Statistical analysis and adaptive sampling techniques can be embedded within existing air traffic simulations to provide several benefits. First, embedded statistical calculations can eliminate the need for extensive storage and post hoc processing of simulated outputs. Second, adaptive sampling can identify the number of observations required for rigorous statistical comparison, often dramatically reducing the number and duration of simulation runs from those predicted a priori by standard statistical techniques, which tend to be quite conservative. Third, these methods facilitate efficient distribution of simulator runs over a network of workstations without requiring parallelization of the simulation software.

This paper describes three central components required for these benefits: (1) embedded statistical calculations; (2) adaptive statistical selection techniques; and (3) the server-client structure for a network of workstations in which individual workstations gather and report interim statistics and then are commanded to perform the further simulation runs required for a given statistical comparison. Their application to air traffic simulation is demonstrated using the Georgia Tech Reconfigurable Flight Simulator in a simulation of a standard terminal arrival route into Atlanta Hartsfield-Jackson airport in which the appropriate simulation runs were automatically carried out until the ‘best’ (or ‘worst’) systems were identified.
An Approach for Predicting Aggregate Operating Daily Airline Schedules

Anand Seshadri, Antonio Trani, and Hanif D. Sherali

This paper develops and analyzes a family of models to predict operating daily airline schedules in the continental United States for future years. The study presented is part of an integrated supply-demand framework to study the evolution of the airline industry. The airline schedule is an important service variable that influences other factors of interest such as demand, profit, and load factor. Our approach attempts to predict the daily airline schedule for a given year, given the annual demand and schedule for the previous year, while minimizing the operating costs due to changes in the schedule. The modeling framework is comprised of three distinct sub-parts: a frequency generator to derive the optimal frequency in a market; a mechanism to obtain an integral solution from a fractional solution produced by the frequency generator; and a timetable generator to derive a daily operating schedule from the output of the second step. The model is validated using actual operating frequency information obtained from the Form 41 traffic data. The model does not attempt to derive an actual airline schedule for any given day, but rather, complements the supply side of an existing supply-demand based strategic simulator for studying the long-term evolution of the National Airspace System (NAS).