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Third International Conference on Research in Air Transportation

Abstract Proceedings

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Welcome from Programme and Conference Chairs

Welcome to the Third International Conference on Research in Air Transportation!

On the behalf of the ICRAT 2008 Organization Committee, we would like to express here our deep gratitude to the senior and young researchers in Air Transportation for having contributed to this young but challenging and exciting conference.

For this third edition of ICRAT, there were 77 qualified submissions by authors from 19 countries. The referee process resulted in 57 acceptances, for an acceptance rate of about 75%, among which 38 submissions were selected as standard papers, and 19 as short papers, representing respectively 50% and 25%. All selected papers, long and short, are of good quality, and we are very proud of the professionalism of all authors, reviewers, and of all Program Committee members. Thank you so much for your contributions and collaborations.

This is also the second year that Tutorials and a Doctoral Symposium are included in the conference program. Seven tutorials on the practice Air Transport are expected to bring up the understanding of how things work for the young scientists. The Doctoral Symposium is expected to create a forum for young researchers to discuss their research approaches with senior researchers to obtain guidelines and supports. The program is even more exciting with the six invited keynote speakers, all senior research scientists or strategists in Air Transportation. We are very grateful for their presence, contributions, and support.

The proceedings you are handling are the result of much hard work from many people. We would like to thank:

- The authors and co-authors of the paper submissions. They are, of course, what makes the conference program great.
- The invisible tertiary reviewers, who often supply the most expert and informed comments on their review, and the ICRAT'08 Scientific Program Committee. There were 40 members who had spent most of their free time during the referee process to review the submitted papers, and to return with careful comments. They are the guardians for the quality of the conference.
- The logistic team, also known as the conference secretariat team and the Webmaster team who worked hard to ensure the on-line processes with the authors, to collect, compile, and edit the final camera-ready proceedings.
- Telecom-Paris Tech with the support to host the website as well as for the time of Pr. Patrick Bellot and Loic Baud, who have worked pro-actively on the development and maintenance of the conference website.
- The Local Organising committee members and volunteers, for the local arrangements, the printing of the proceedings, and all the logistics at the conference place.
- The various institutions that provided the support for the paper process. The list includes the employers of all authors and co-authors and the employers of all reviewers and committee members.

Thank you all again, authors and reviewers, for your contribution to ICRAT'08 that surely be exciting. Thanks once more to the conference secretaries: Loic Baud, Simone Rozzi, Andrea Ranieri, Stephen Peterson, Ronish Joyekerun and the Publication Chair John Shortle to be the bridge between the Program Committee, the authors, and the Local Organisers. The success of this conference will be yours!

Andres Zellweger, General Chair,
George Donohue, Conference Chair,
Vu Duong, Program Chair.

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TRACK 1

Advanced Modelling

Passenger Trip Delays in the U.S. Airline Transportation System in 2007

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Abstract— **The value of the air transportation system is the transportation of light-weight, high-value cargo, and passengers. Industry and government metrics for the performance of the air transportation focus on the performance of the flights. Previous research has identified the discrepancy between flight performance and passenger trip performance, and has developed algorithms for the estimation of passenger trip performance form publicly available data. This paper describes an analysis of passenger trip delays for 5224 routes between 309 air ports in the U.S. air transportation system for 2007. The average trip delay experienced by passengers was 24.3 minutes for nationwide total of 247 Million hours. Flights delayed 15 minutes or more contributed 48% of the total delays, cancelled flights 43%, diverted flights 3%, and flights delayed less than 15 minutes contributed the remaining 6%. Passenger trip delays for oversold flights were negligible. Analysis of passenger trip delays for routes and airports, and the implications of these results are also discussed.**

Keywords— passenger trip delay; flight delay, airport delay.

Constructing a Passenger Trip Delay Metric

An Aggregate-level Approach

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Abstract—**The on-time performance of passenger trips has received a great attention from government agencies in recent years but lacks a systematic metric to measure or trace the impact of flight delay to air travelers. The proposed model considers possible trip types of a passenger, utilizes system-wide flight-based performance metrics, and employs statistical approaches in order to develop an aggregate delay metric from passenger's perspective. Its results can be used to analyze historical passenger schedule reliability and can also be used to predict passenger experience for future aviation system.**

Keywords—delay, passenger trip, performance metric, air travel

Filtering and Aggregation Schemes for Delay Model Calibration

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Abstract—**This paper describes some methods for filtering and aggregating delay data from individual flights. The purpose for these transformations is to make the delay data more consistent with the outputs from queuing models. The transformed data can then be used to make much more relevant, and successful, comparisons against such models. This enables better calibration of the models, and helps to reveal what fraction of the total delay in a system might be generated solely from the consideration of congestion resulting from competition amongst aircraft for scarce airspace and airport resources. The paper describes the transformations in detail, and demonstrates their theoretical validity through examples. Real data are modified according to these transformations and are then compared against a stochastic queuing model to show the efficacy of the technique.**

Keywords—queuing models, airport delay, delay filtering

The Impact of Ground Delay Program (GDP) Rationing Rules on Passenger and Airline Equity

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Abstract— **The discrepancy between the demand for arrival slots at an airport and the available arrival slots on a given day is resolved by the Ground Delay Program (GDP). The current GDP rations the available arrival slots at the affected airport by scheduled arrival time of the flights with some adjustments to balance the equity between airlines. Current rationing rules do not take into account passenger flow efficiency in the rationing assignment tradeoff. This paper examines the tradeoff between flight delays and passenger delays as well as airline equity and passenger equity in GDP slot allocation. A GDP Rationing Rule Simulator (GDP-RRS) is developed to calculate efficiency and equity metrics for all stakeholders. A comparison of alternate GDP rationing rules identified that passenger delays can be significantly decreased with a slight increase in total flight delays. Compared to the traditional Ration-by-Schedule, Ration-by-Aircraft size (RBAc) decreased the total passenger delay by 10% with 0.4% increase in total flight delay, and Ration-by-Passengers (RBPax) decreased total passenger delay by 22% with only 1.1% increase in total flight delay. The disutility of implementing a GDP is minimized with Ration-by-Passengers (RBPax) when passengers as well as airlines are considered in the decision. The current scheme, Ration-by-Schedule RBS), is preferred only when the system solely focus on airlines. The tradeoffs between airline and passenger equity, and the implications of these results are discussed.**

Passenger Flow Simulation In A Complex Networked Transportation System

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***Abstract*—Passenger trip time performance is positively correlated with passenger satisfaction, airfare elasticity, and airline profits. Researchers have demonstrated that flight metrics are a poor proxy for passenger trip experience. Trip delays experienced by passengers due to missed connections and cancelled flights are not negligible. This paper describes a passenger flow simulation which captures the asymmetric and unique passenger trip on-time performance and reflects the complexity and significance of the impact of a small set of cancelled flights and missed connections on passenger trip delays. It measures system performance from the flying public's view. Furthermore, it enables researchers to conduct experiments outside the range of historical data. The results of this research provide decision makers with improved metrics for future investment decisions and better tools to manage the system. The passenger flow simulation model also provides the means to perform analysis for proposed changes to the system.**

Keywords—on-time performance; passenger flow; performance metrics; passenger trip time

Modeling Stochastic Evolution of Runway Capacity Using Data Mining Concepts

Case Study of San Francisco International Airport (SFO)

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***Abstract*— Variation in airport runway capacity, including arrival and departure is one of the main causes of operational disruptions such as flight delays and cancellation. In the ideal situation, we will know the exact timing and magnitude of such variations and plan accordingly to minimize such impacts. In reality however, capacity evolution process is probabilistic and determined by numerous factors. Capacity scenarios are the probabilistic representation of capacity variation at daily level. Scenarios provide probabilistic representation of capacity profiles to reduce modeling complexity of capacity prediction model. There are two data domains one can use to generate capacity scenarios; historical data, and day-of-operation information. While historical data provide long-term trend of capacity variation at an airport, day-of-operation information can increase the**

accuracy of the likelihood of each scenario on a given day. In this paper, we explore various Data Mining (DM) approaches to understand the historical trend of Airport Acceptance Rate (AAR) at San Francisco International Airport (SFO). We revisit earlier research based on k-means clustering. Among other shortcomings of k-means application, it lacks the sequential and time-dependent nature of AAR evolution. We first construct the Directed Acyclic Graph of AAR evolution to understand the conditional dependency among different time periods. Based on our observation that AAR change is mostly Markovian, we apply Sequence Clustering to properly address sequential nature of AAR evolution. In the later section, we include the preliminary result of Bayesian approach that utilizes weather information. In the last section we discuss the applicability of Data Mining concepts in aviation research, and future directions of our runway capacity modeling research.

Keywords—component; terminal capacity; data mining; Bayesian learning; capacity prediction; AAR; scenario generation

Deconstructing Delay:

A Case Study of Demand and Throughput at the New York Airports

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Abstract— **This paper introduces an empirically driven, non-parametric method to isolate and estimate the effects of demand and throughput changes to observed changes in flight delay. Classical queuing model concepts were used to develop a method by which an intermediate queuing scenario could be constructed, in order to isolate the delay effects due to shifts in demand and throughput. This method includes the development of a stochastic throughput function that is based entirely on data and as a result has two advantages: it uses non-parametric, empirically-based probability distributions, and capacity need not be estimated explicitly. The method was applied to a case study of the three major New York airports of LaGuardia (LGA), John F. Kennedy (JFK), and Newark Liberty (EWR), for the peak summer travel seasons of 2006 and 2007, using data extracted from ASPM. This case study was of particular interest given that these airports experienced record levels of delay in 2007. The simulation results were consistent with both OPSNET and ASPM data, and were successful in quantifying the delay effects of demand and throughput changes from 2006 to 2007.**

Keywords—delay; demand; throughput; capacity; runway operations; New York airports; simulation; probability; ASPM; OPSNET.

Propagation of Airspace Congestion. An Exploratory Correlation Analysis

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Abstract—**We analyze how large gaps between the planned and realized number of aircraft into flight sectors propagate through the European- and the Japanese Airspace. For this we analyze the sample cross-correlation matrix of the most congested part of the networks. Because of the motion of aircraft, gaps propagate to neighboring sectors, expecting positive correlation coefficients. The question in the analysis is whether there are unexpected coefficients. Such coefficients would be caused by traffic controllers or flow managers who compensate for strong gaps by re-routings or speed adjustments. Such strategies would often lead to negative correlation coefficients. Our results show that meaningful correlations appear on two levels: (i) locally, that is between a sector and its direct neighbors and (ii) globally on 'traffic highways', that is between sectors that are connected through a flight route with high traffic densities. This is true for both, the European- and the Japanese Airspace. Moreover, all correlations are positive and their time-lags correspond to the average travel times. No unexpected correlations have been found. We conclude that no systematic strategies to compensate strong delays are applied by controllers. The results are useful to justify predictive congestion models for future flow planning. They also give a first insight into how controllers deal with their workload, although a more detailed analysis is required to explore this topic.**

Keywords—Flow analysis, correlation analysis.

Smoothed Traffic Complexity Metrics for Airspace Configuration Schedules

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***Abstract*—This paper is a continuation of previous research on optimal airspace configuration. It is expected to improve the predictability and the flexibility of the airspace management process by computing realistic predictions of the sectors opening schedules in En-route ATC centers. In previous papers, we selected relevant complexity metrics to predict the controllers workload, using neural networks trained on recorded airspace configurations. We also introduced new algorithms to build optimally balanced airspace configurations, exploring all possible combinations of elementary sectors. As a result of this previous work, we were able to compute realistic schedules on a whole day of traffic, using complexity metrics that were computed from recorded radar tracks. The raw metrics, however, showed high variations in time which caused a "configuration switching" phenomenon. Although the number of control sectors in the computed schedule stayed globally close to the recorded number of sectors, the airspace was reconfigured much more often than in reality. The present paper shows how the input metrics can be smoothed in order to avoid this problem, and what may be the subsequent problems caused by the smoothing strategy.**

Network Restructuring Models for Improved ATS Forecasts

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***Abstract*—Current air traffic forecast methods employed by the FAA function under the assumption that the flight route network will not change, that is, no new flight routes will be added and no existing flight routes will be removed. However, in reality the competitive nature of the airline industry is such that new routes are routinely added between cities possessing significant passenger demand while other city-pairs are removed. This paper investigates models for forecasting network reconfiguration that exploit knowledge of network structure in the Air Transportation System (ATS), with the goal of improving overall forecast that drives policy and infrastructure enhancement decision-making.**

Keywords—forecast; network theory; air traffic

Resource Allocation in Flow-Constrained Areas with Stochastic Termination Times

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***Abstract*—In this paper we formulate an optimization problem for the assignment of dispositions to flights whose preferred flight plans pass through a flow-constrained area. For each flight, the disposition can be either to depart as scheduled but via a secondary route that avoids the flow-constrained area, or to use the originally intended route but to depart with a controlled departure time and accompanying ground delay. We anticipate that the capacity through the flow-constrained area will increase at some future time once the weather activity clears. The model is a two-stage stochastic program that represents the time of this capacity windfall as a random variable, and determines expected costs given a second-stage decision, conditioning on that time. The goal is to minimize the expected cost over the entire distribution of possible capacity increase times.**

Trajectory Prediction: A Functional Regression Approach

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***Abstract*—Accurate trajectory prediction is an important issue for decision support tools in the field of ATM. This paper presents a new approach that considers trajectories as points in a functional space. By finding a expansion of observed trajectories on a suitable basis and truncating the expansion to a finite number of terms, standard regression algorithms can be used. Within this framework, full segments of trajectories can be forecasted up to 10-15 minutes.**

Keywords—Functional regression, Functional data, Trajectory Prediction

The Robust Flight Level Assignment Problem

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***Abstract*—This paper studies the robust flight-level assignment problem. Our goal is reducing the cost (and more specifically the delay) induced by airspace congestion through an appropriated flight level assignment (FLA) taking account of uncertainties. We investigate a robust optimization framework inspired by Bertsimas and Sim work for linear programs and propose appropriate models for the robust flight level assignment problem.**

Keywords—Flight-level assignment, Robustness, Linear programming.

Stochastic Airspace Demand for Strategic Traffic Flow Management

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***Abstract*— In this paper we consider the problem of predicting the demand for en route airspace sectors considering uncertain flight departure time and en route conditions. Flight, airport, and airline conditions that lead to greater variance in departure time prediction errors are examined and used to develop kernel-smoothed empirical probability density functions for flight departure time predictions. The structure of the departure time prediction errors is found to vary across the departing airport type. A similar analysis is performed for the en route airspace to characterize the random component of airspace sector traversal time. Variance of en route sector traversal times is found to increase for shorter duration planned sector traversal times. A method that combines these sources of uncertainty is presented and applied to two days of historical traffic conditions for east coast U.S. airspace sectors. Results of this analysis indicate that the mean absolute prediction error of the airspace demand can be reduced by 20% when using the probabilistic method as compared to a deterministic procedure. Similarly, standard deviation of the error in airspace demand is reduced by 23 to 25% also indicating a reduced spread in the demand estimation.**

Keywords—en route; airspace; traffic flow management; demand; probabilistic

Modeling the Operational Impact of Air Traffic Control Automation Tools:

A Case Study of Traffic Management Advisor

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***Abstract*— Traffic Management Advisor (TMA) is a decision support tool developed to assist Traffic Management Units (TMU) in metering and sequencing arrival traffic. This study examines the use and impact of TMA during its early stages of deployment at Chicago Center (ZAU). Determining impacts of use presents a methodological challenge because usage may depend on weather and traffic conditions, possibly leading to spurious results if simple with/without comparisons are made. In an effort to isolate the impact of TMA, this study therefore employs an alternate method. A preliminary understanding of TMA use is established through summary statistics. This enables the development and use of detailed statistical models to isolate the impact of TMA at ZAU. We find evidence through these detailed models that TMA use increased capacity in specific conditions and capacity variability was reduced in all scenarios. A simulation of these results on delay at Chicago O'Hare International Airport (ORD) showed that TMA use can decrease delay by 33%.**

Keywords—Air Traffic Management, Capacity, Traffic Management Advisor

TRACK 2

CNS/ATM

Limitations of Subliminal Control in Air Traffic Management

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***Abstract*—An air traffic control concept under the name of *Subliminal Control* has been introduced. In this approach, an automated system, commanding minor speed adjustments imperceptible by the Air Traffic Controller, tries to keep the Air Traffic Controller's risk perception low, emulating a "lucky traffic". In this paper, we investigate the limits of this air traffic control approach. We test a proposed subliminal controller against several encounter geometries for level flights. A stochastic environment using wind forecast uncertainties is used for this purpose. The results demonstrate the cases where subliminal control can potentially reduce the workload of the ATC.**

Distribution of Longitudinal Speed Prediction Error of ADS-C System

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***Abstract*—The number of aircraft flying in oceanic airspaces is growing. To accommodate the traffic growth, the reduction of separation minimum for Automatic Dependent Surveillance – Contract (ADS-C) aircraft is required. However, the reduction of the separation minimum increases the collision risk of aircraft and the safety assessment prior to the reduction is expected. The probability distribution model of the longitudinal speed prediction error is a key parameter of the collision risk formula for the longitudinal separation minimum under ADS-C. In this paper, the empirical distribution of the longitudinal speed prediction error of aircraft in North Pacific routes is provided. Using Peak over Threshold (POT) technique, we found the distribution model which is appropriate for the risk estimation.**

Keywords—component; Automatic Dependent Surveillance – Contract (ADS-C), Longitudinal Speed Prediction Error, Peak Over Threshold, Collision Risk

Three-Degree Decelerating Approaches in Arrival Streams

Continuous Descent Approaches in High Traffic Density

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***Abstract*—Self-spacing is a solution for the runway capacity reduction that is intertwined with the use of continuous descent approaches in the current air traffic management system to reduce aircraft noise. In case of self-spacing the separation task is transferred from the air traffic controller to the pilot. The Three- Degree Decelerating Approach (TDDA) can be executed in a distance- or time-based self-spacing environment while yielding a noise reduction. A fast-time simulation tool has been developed to simulate arrival streams of different aircraft types executing the TDDA in both self-spacing scenarios under actual wind conditions. The tool was used to quantify the performance differences between distance- and time-based self-spacing in terms of capacity, noise reduction, and loss of separation. In the time-based scenario no effects of preceding aircraft on trailing aircraft could be identified. However, an increase in separation with a negative effect on the airport capacity in order to assure safe separation was required. In the distance-based self-spacing scenario a slow-down effect was observed that led to a decrease in the noise reduction towards the end of the arrival stream. This was solved by altering the initial separation between aircraft in the arrival stream. In the distance-based self-spacing scenario no negative effect on the runway capacity or safety has been identified.**

Keywords—-Continuous Descent Approach, capacity, selfspacing

Separation Minima Standards:

Research of Current Applicable Minima Laid Down and Foundations

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Abstract— **Separation Minima (SM) is the minimum distance a/c need to fly apart from each other at all times to ensure safety. This applies to the three axes: Vertical, Lateral and Longitudinal Separations Minima (See Figure 1. A/c Separation Axes). Many Standards of Separation Minima were defined based on expert judgment and technology available at the time were laid down them, the leap in technology since then makes the SM standards must be updated. However, many of them have not been modified to reflect modern technological capabilities. Due to how SM have been defined (in many cases) makes each region around the world have laid down different values for same operational case or separation rules were laid down with different criteria and context descriptions. As demand is expected to treble by 2020, one of the ATM system challenges is to manage the expected increase in air traffic demand and, reducing SM becomes a potential solution part that would contribute to achieve this challenge, keeping always in mind that a/c Separation Standards reduction increases airspace capacity but can also reduce safety levels, which must be preserved as part of the challenge**

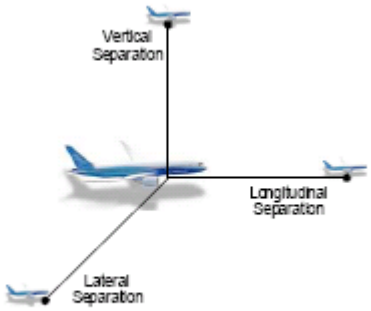

Figure 1. A/c Separation Axes

The best starting point in order to identify which reductions in SM could be realized is undertaking a research of the current separations minima and their foundations. Answering the questions what? and why?, will make it someday possible to answer the question how?. The work that the present paper originated from was focused on extracting information from several international regulations and (ICAO, FAA, British Regulations, Australian Regulations, Canadian Regulations and Eurocontrol). These regulations/documents include a/c separation minima cases, description of SM values classified by PoF, a/c operation, direction/tracks/routes, conditions and operational context, technology involved, separation axis. In addition, identifying aerodynamic factors, human factor, hazard/risks, equipment precision, surveillance mode, models identification, etc were also investigated. The valuable results of this research are unprecedented in their contents and for the useful way to they are presented.

TRACK 3

Safety and Security

A Review of the Research on Risk and Safety Modelling in Civil Aviation

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***Abstract*— Risk and safety are always considered the most important operational characteristics of contemporary civil aviation. Usually, they refer to the potential occurrence of air traffic accidents which might result in loss of life, damage to infrastructure and third party property damage. Consequently, they have been regarded as externalities in addition to other adverse effects such as noise, air pollution, land-use, water/soil pollution, waste, and congestion. Due to their inherent very high importance, risk and safety have been issues of continuous research ranging from purely technical/technological aspects to strictly institutional. These issues warrant the setting up of adequate regulations on system technology designs and operations. This paper deals with a review of part of the research on risk and safety modeling in civil aviation. In such a context, the basic (generic) concepts and definitions of risk, safety and their evaluation are described. A review of the research is focused on four categories of methods/models for risk and safety assessment: causal for aircraft and air traffic control/management (ATC/ATM) operations, collision risk, human factor error and third-party risk. The review is carried out with respect to their purpose, problems, recommendations and relation to new technologies.**

Keywords—civil aviation, risk and safety, models/methods, new technologies.

Accident Risk Analysis Benchmarking Monte Carlo Simulation versus Event Sequences

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***Abstract*—Fault and event trees are the dominantly used safety risk models in air traffic. Systemic accident risk assessment by Monte Carlo simulation is a more recent technique, the power of which is less explored. In this paper we compare the two approaches for an accident risk analysis of an active runway crossing operation that is supported by a runway incursion alerting system for the runway controller. For this example we show and explain remarkable differences in results obtained using the two approaches.**

Keywords—runway crossing; runway incursion; collision risk; stochastic systems; Monte Carlo simulation; event sequence analysis; alert system

Analyzing Relationships Between Aircraft Accidents and Incidents

A data mining approach

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***Abstract*—Air transportation systems are designed to ensure that aircraft accidents are rare events. To minimize these accidents, factors causing or contributing to accidents must be understood and prevented. Previous research has studied accident data to determine these factors. The low rate of accidents however, makes it difficult to discover repeating patterns of these factors. In this research we employed a data mining technique to conduct a holistic analysis of aircraft incident data in relation to the accident data. The analysis identifies relationships between the accident and incident data and finds patterns of causal and contributory factors which are significantly associated with aircraft accidents.**

Keywords—aviation safety; aircraft accidents; aircraft incidents; data mining; contrast-set mining

ATC Complexity as Workload and Safety Driver

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***Abstract*— This paper describes an investigation into ATC complexity as a contributory factor in changes of safety level. ATC complexity, together with equipment interface and procedural demands comprise the task demands on the controller; subsequent controller activities are mediated by performance shaping factors to create workload. In order to establish a link between ATC complexity, a controller's subjective workload and safety, complexity factors are identified and subsequently related to both workload and safety indicators. The studied data comes from a real-time simulation using controller-pilot data-link communication (CPDLC) technology, recently completed at EUROCONTROL CRDS in Budapest.**

Keywords—ATC complexity; task demands; controller's activity; workload; safety

Assessment of Local Aircraft Crash Risk

Application of a cluster analysis as a statistical method for detecting similar airports

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***Abstract*—The assessment of local aircraft crash risks in the vicinity of airports is of primary importance in numerous safety studies relating to the determination of Third Party Risk due to aircraft accidents. This paper presents an approach of determining local aircraft crash rates by means of a cluster analysis. This statistical method detects similarities between airports in consideration of safety relevant parameters.**

Keywords—Safety, aircraft crash risk, accident ratio, External Risk, similarity analysis, cluster analysis

Hybrid System Framework for the Safety Modelling of the In Trail Procedure

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***Abstract*—The purpose of this paper is to provide a framework based on hybrid systems theory for safety modelling in air traffic management applications. This framework can be used to represent complex multi-agent applications in which a wide set of possible abnormal scenarios has been considered. In the aviation context possible catastrophic events can take place due to an error of a single agent involved in the procedure. It will be shown how the hybrid system framework allows a description and detection of these errors and their effects on the evolution of the procedure. At first it is proposed a description of the ASEP-In Trail Procedure which has been chosen to illustrate the methodology. Then, a general view about hybrid systems is proposed in order to explain the mathematical environment. Once basic concepts have been introduced, the hybrid model of the ASEP-ITP is explained and the concept of critical observability is introduced. Finally, an hybrid observer is proposed in order to detect unsafe situations associated with the hybrid system evolution.**

Keywords—Safety Modelling, Hybrid Systems, Critical Observability, Air Traffic Management, In Trail Procedure.

Proactive, Reactive, and Interactive Risk Assessment and Management of URET Implementation in Air Route Traffic Control Centers

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***Abstract*—The current trend within air traffic management (ATM), as a part of the Next Generation Air Transportation System (NextGen), is to increase the airspace system capacity to operate in diminishing capacity conditions while improving standards of safety. An extensive body of research exists regarding introducing automation into air traffic control in order to create more flexible and cost-efficient operations. The User Request Evaluation Tool (URET) is a strategic support tool designed to assist controllers with timely detection of conflicts; it offers tools for checking the conflict resolution clearances. This study develops general proactive, reactive, and interactive approaches for the risk assessment and management of the system in order to achieve quality (safety and serviceability) and reliability; it also presents a case study of URET implementation in Air Route Traffic Control Centers in the past ten years. First, the reactive approach, used in URET deployment, is developed, followed by developing the complementary and necessary proactive and interactive approaches. Safety Management and Assessment (SMAS) evaluation is performed for the reactive approach. Findings show that many factors led to cases of URET usage deviating from that provided for in the original design, and for using URET less often than it was originally intended.**

Keywords—Air Traffic Control, en route, URET, performance shaping factors, proactive, reactive, interactive, risk assessment and management, SMAS

TRACK 4

Decision Support Tools

Decision Support Tool for Predicting Aircraft Arrival Rates, Ground Delay Programs, and Airport Delays from Weather Forecasts

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***Abstract*—The principle "bottlenecks" of the air traffic control system are the major commercial airports. Atlanta, Detroit, St. Louis, Minneapolis, Newark, Philadelphia, and LaGuardia all expect to be at least 98% capacity by 2012. Due to their cost and the environmental and noise issues associated with construction, it is unlikely that any new airports will be built in the near future. Therefore to make the National Airspace System run more efficiently, techniques to more effectively use the limited airport capacity must be developed. Air Traffic Management has always been a tactical exercise, with decisions being made to counter near term problems. Since decisions are made quickly, limited time is available to plan out alternate options that may better alleviate arrival flow problems at airports. Extra time means nothing when there is no way to anticipate future operations, therefore predictive tools are required to provide advance notice of future air traffic delays. This research describes how to use Support Vector Machines (SVM) to predict future airport capacity. The Terminal Aerodrome Forecast (TAF) is used as an independent variable within the SVM to predict Aircraft Arrival Rates (AAR) which depict airport capacity. Within a decision support tool, the AAR can be derived to determine Ground Delay Program (GDP) program rate and duration and passenger delay. The introduction of this decision support tool will expand the amount of time available to make decisions and move resources to implement plans.**

Pilot Support for Flying Curved Decelerating Approaches in Realistic Wind Conditions

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***Abstract*—The most promising aircraft noise abatement approach procedures are those that combine flying longer at high altitude with continuous descents in a near-idle thrust setting. Although very effective at mitigating noise impact on the populated areas that surround airports, these procedures reduce runway capacity with respect to standard ILS approaches. Large uncertainties in descent trajectories force air traffic controllers to apply large separations in order to ensure safe operation. In this paper, a solution is presented that addresses the problems of variability in deceleration profiles and wind uncertainty. Spacing is done by providing pilots with a required time of arrival. A support system then helps the pilot in meeting this time goal.**

A wind prediction algorithm has been developed that creates a wind profile estimate along the intended three dimensional approach track, using filtered wind data observations broadcast by nearby aircrat. By combining accurate wind estimates with a flap scheduling algorithm, accurate track and speed guidance is available on-board. An interface has been designed that aids the pilot both in flying a controlled continuous descent approach and in meeting the time target set by air traffic control. To test the combined support system, a piloted simulator experiment was set up. Performance in terms of time goals was found to be consistent under all tested conditions and significantly better in comparison with the non-supported condition. Also, workload is significantly lower with the display optimization present. Providing the pilot with continuously updated time performance information based on actual meteorological circumstances was shown to be an important requirement for the implementation of CDAs in a time based spacing environment.

Index Terms—continuous decent approach, wind prediction, trajectory prediction, pilot guidance

Developing a Decision-Support-Tool for an Air Taxi Service

A research proposal to develop a decision support tool to analyze an air taxi service on strategic and operational level

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***Abstract*—this paper is a research proposal to develop a tool to analyze logistic concepts of the air taxi service of Aeolus Aviation in different scenarios. Based on this analysis recommendations can be done for a suitable logistic concept for Aeolus. Based on background analysis of the air taxi service three objectives are formulated; analyzing the air taxi service on strategic level, developing a decision support tool to analyze logistic concepts and finally developing a suitable logistic concept for Aeolus Aviation. Based on these objective research questions are formulated and research methods to answer these questions are given.**

Keywords—component; Air taxi, complexity, Research proposal,decision support tool, simulation

Route Preliminary Demand Forecast Model

For All-Business Airlines or Flights

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***Abstract*—From 2005 onward, a number of new low-cost all-business airlines have emerged in the transatlantic market. All of these airlines have aggressive plans for expanding their route network. This paper describes the development of a preliminary forecasting tool, to be used by such airlines in a preliminary profitability study of new or current routes. This means the model can be used to assess both the profitability of a new route of interest and of continuing an existing route. The model in its current state indeed provides this capability. This is shown using a rough validation calculation, carried out using the model and based on the business case of Eos Airlines, one of the recently erected all-business airlines. The model's forecasting accuracy is still fairly limited. To improve this, more research should be conducted on both the refinement of the model as on the data required for using the model.**

Keywords—all-business airlines, demand forecast, demand drivers, air travel routes, business travel.

TRACK 5

Human Factors and Interfaces

An Infovis Approach to Compare ATC Comets

Comparing visual entities with a theoretical foundation

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***Abstract*—Air Traffic Control systems display information with multiple visual entities. The research described in this paper is an initial effort to develop a theory-driven approach to the characterization of visual entities. We enhance the state of the art in data visualization to characterize four "comet" designs. This work helps to understand visualization more precisely and provides a basis to help the designer to formally assess the effectiveness of their work.**

Keywords—Information Visualization, design, taxonomy, graphical coding.

Functional Analysis of Human-Human Interactions during Collaborative Decision Making in Flight Operation

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***Abstract*—The objective of this study is to understand the cooperation building process within Human-Human Interaction (HHI) during Collaborative Decision Making (CDM) at a distributed decision making environment across objective functions. It is based upon functional HHI analysis within typical Air Traffic Management (ATM) operation situations. In this paper, different flight and turn-round operation situations are compared and characterized by: (1) a synchronous interaction mode, where all participating operators interact with each other at the same time, and (2) an asynchronous interaction mode, where the participating operators interact with each other at different times. In both situations, only HHI which require cooperation among operators across different locations and objective functions are contemplated. Interactions take place through a written text or speech. Task and decision making for all situations is distributed between operators. The aircraft pilot's perspective and their information requirements during these flight and turnround situations are used to identify critical information processing during CDM: All situations are usually time constrained, change quickly, and require a highly dynamic information transfer. Thereby, information sharing for decision making can be either homogenous having all operators the same information required or heterogeneous where information is not equally shared among operators. This study relies on a structural model of team collaboration, developed for analysis on the cognitive mechanisms of CDM, and to handle both synchronous/ asynchronous and collocated/ distributed collaboration environments like in geographically distributed and time delayed situations of the military or flight operation.**

Keywords—Air traffic management, asynchronous distributed collaboration, collaborative decision making, human-human interaction

Responding to Uncertainty on Approach in Hazardous Situations

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***Abstract*—The management of uncertainty is a recurring theme n Air Traffic Management and in understanding the way perators accomplish their objectives in a complex, dynamic nvironment. The current study reports on the verbal communication processes of crews and controllers during the approach flight phase and faced by uncertain situations. A conversation analysis of six (6) accident transcripts was conducted, with dynamic environmental interactions as a complexity factor. The results are presented in the forms of correlations among factor pairs. Results indicate a large variation (5.46%-32.09%) of the detection of uncertainty across accidents. Air Traffic Control and Ground Services (ATC/Ground) rarely initiated problem-solving exchanges (7%) in uncertain situations, as compared to crews (93%). Crews initiated 80.6% of problem-solving exchanges based on the direct perception of environmental cues while ATC/Ground initiated 19.4% of exchanges based only on indirect cues. Finally, our results indicate that ATC/Ground account for 68.8% of overlapping and 88.9% of compounded verbal exchanges. We conclude that the response to uncertain situations arising from hazardous conditions seems to correlate with a management by crews on approach. The effective transfer of uncertainty cues between crews and controllers does not appear to correlate with collaborative and communicative practices.**

Keywords—Uncertainty; Adaptation; Environmental Hazards;Verbal; Conversation Analysis; Air Traffic Management.

Automation for Task Analysis of Next Generation Air Traffic Management Systems

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***Abstract*—The increasing span of control of Air Traffic Control enterprise automation (e.g. Flight Schedule Monitor, Departure Flow Management), along with lean-processes and pay-for-performance business models, has placed increased emphasis on operator training time and error rates. There are two traditional approaches**

to the design of Human-Computer Interaction (HCI) to minimize training time and reduce error rates: (1) experimental user testing provides the most accurate assessment of training time and error rates, but occurs too late in the development cycle and is cost prohibitive, (2) manual review methods (e.g. cognitive walkthrough) can be used earlier in the development cycle, but suffer from poor accuracy and poor inter-rater reliability. Recent development of "affordable" human performance models provide the basis for the automation of task analysis and HCI design to obtain low cost, accurate, estimates of training time and error rates early in the development cycle. This paper describes a usability/HCI analysis tool that this intended for use by design engineers in the course of their software engineering duties. The tool computes estimates of trials-to-mastery (i.e. time to competence for training) and the probability of failure-to-complete for each task. The HCI required to complete a task on the automation under development is entered into the web-based tool via a form. Assessments of the salience of visual cues to prompt operator actions for the proposed design are used to compute training time and error rates. The web-based tool enables designers in multiple locations to review and contribute to the design. An example analysis is provided along with a discussion of the limitations of the tool and directions for future research.

Keywords—Human Computer Interaction, Usability Analysis, Task Analysis, Probability of Faiure to Complete a Task, Trials to Mastrery.

Human-Centred Innovation: Developing 3D-in-2D Displays for ATC

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Abstract—**User-Centred Design is extremely useful for improving existing tasks and technologies, however it is less useful for innovation. This paper documents User-Centred Innovation and how it was implemented in the Air Traffic Control domain.**

Keywords—User-Centred Innovation, Air Traffic Control, Augmented Reality

Embedded Eye Tracker in a Real Aircraft: New Perspectives on Pilot/Aircraft Interaction Monitoring

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Abstract—**Currently, online assessment of the aircrew performance focuses on behavioural data (flight data and pilot's actions) and the detection may intervene too late for coping with the situation degradation. An early assessment of the pilot's "internal state", based on physiological data collected from his autonomous nervous system (ANS) and predictive of his behaviour, is necessary. These data give clues both on the cognitive activity and on the emotional states and stress. The integration of ANS devices in a cockpit presents practical drawbacks and their use is often limited to simulators. In this preliminary study, the pros and cons of the adaptation of a standalone eye tracker in a light aircraft are presented. In spite of a sensitivity to light conditions and a definition of areas of interest limited to a part of the cockpit, the eye tracker has provided interesting behavioural (fixations) and physiological (pupillometry) measures in nominal (from take-off to landing) and degraded (provoke a simulated engine failure and plane down toward the airfield) conditions. The pilots spent less time glancing at the instruments, and focused on less instruments in the degraded condition. Moreover, the pupil size varied with the flight phases in the degraded condition, which reflected the variations of stress and attention levels. These encouraging results open two tracks: the development of new eye trackers able to overcome current technical limitations, and neuroergonomics researches providing guidelines for new man-machine interfaces integrating both flight and crew state vectors.**

Visual Cognition Abilities in X-Ray Screening

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Abstract— **The job of aviation security screeners is a highly demanding task. Based on the x-ray image of a passenger bag, a screener has to decide within few seconds only whether the bag is ok or has to be hand-searched. This x-ray screening task includes specific knowledge and visual cognition abilities. The knowledge about which items are prohibited and what they look like in x-ray images of passenger bags have to be learned on the job. In contrast the ability to cope with high bag complexity, superposition and viewpoint of threat items is relatively stable and can only be improved little with on the job training. Whether these abilities can be measured within a pre-employment assessment procedure using different subtests of well established intelligence test batteries was investigated in this study. Results revealed a relationship between the latent variable ability and detection performance in x-ray screening for both samples. However, 4 of the 12 intelligence tests are sufficient to explain detection performance in x-ray screening. The relationship between the latent variable ability, the X-Ray Object Recognition Test and detection performance later on the job was tested additionally.**

Keywords—Abilities, aviation security, visual cognition, x-ray screening

The Impact of Image Based Factors and Training on Threat Detection Performance in X-Ray Screening

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Abstract—**In this study, two experiments are reported which investigated the relative importance of five different image based factors and one human factor (training) in mediating threat detection performance of human operators in airport security x-ray screening. Experiment 1 was based on a random sample of roughly 16'000 records of threat image projection (TIP) data. TIP is a software function available on state-of-the-art x-**

ray screening equipment that allows the projection of fictional threat images (FTIs) into x-ray images of passenger bags during the routine baggage screening operation. Analysis of main effects showed that image based factors can substantially affect screener detection performance in terms of the hit rate (identification of FTIs). There were strong effects of FTI view difficulty (rotation of FTIs) and superposition of FTIs by other objects in the x-ray image of a passenger bag. The amount of opacity in the x-ray image of a passenger bag had a small although significant effect on detection performance. The two image based factors clutter and bag size did not have a significant effect. Experiment 2 was conducted using an offline-test in order to provide controlled and more detailed data for analyzing the image based factors from Experiment 1, as well as the human factor of training. In particular the individual factors' main effects on detection performance, main effects of all factors taken together and factor interactions were analyzed. In the test design the following image-based factors were varied systematically: Threat (FTI) category (guns, knives, improvised explosive devices, other threats), view difficulty, superposition, bag complexity (a combination of opacity and clutter) and bag size. Data were collected from 200 screening officers at five sites across Europe. For screener training all five sites use the same computer-based training system. Consistent with the results obtained in Experiment 1, there were large main effects of threat (FTI) category, view difficulty, and superposition. Again consistent with Experiment 1, effects of bag complexity (opacity and clutter) and bag size were much smaller. In addition to Experiment 1, the number of computer based training (CBT) hours was available for each security officer participating in the study. Training turned out to be a key driver to improving threat detection performance in x-ray screening and seemed to mediate the effects of some image based factors. Possible implications regarding the enhancement of human-machine interaction in x-ray screening are discussed.

TRACK 6

Airport Operations

Comparison of Data Envelopment Analysis Methods Used in Airport Benchmarking

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Abstract—**Airport efficiency has been shown to contribute to the overall performance efficiency of the air transportation network. Airport performance efficiency is benchmarked annually and widely published. These benchmarks use several techniques, including several Data Envelopment Analysis (DEA) methods. This paper examines the differences in results using three DEA methods (Cooper-Charnes-Rhodes (CCR), Banker-Charnes- Cooper (BCC), and Slacks-Based Measure of efficiency (SBM)) on data from 45 airports from 1996 to 2000. The results from the three DEA methods yielded wide variation in results. For example, the CCR analysis showed that efficiencies degraded from small to medium to large airports. The BCC analysis showed no significant difference in efficiency among the three classes of airports. The SBM analysis yielded degraded efficiency from large to medium to small airports. The implications of these results on the use of DEA in benchmarking and the need for guidelines for selection of DEA models and the interpretation of DEA results is discussed.**

Keywords—Data Envelopment Analysis; CCR; BCC; SBM; airport efficiency

Improving Aircraft Turn Around Reliability

Specific Aircraft Body Design Parts hamper Ground Handling and Airport Performance

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Abstract—**The Airport, and specifically the turn around time (TAT) of aircraft at the gate or a remote position from the terminal have been recognized as crucial element to ATM system performance. Currently, the TAT ranges around 30 min for short/medium range aircraft. For the 2020 Single European Sky, SESAR claims as performance target for a cut down to 15 min while also increasing process reliability. There are several reasons, why the turn around is still remarkably uncertain, mainly caused by shared responsibility for the individual ground handling processes, a frequent distortion of gate occupancy schemes at the airport and still deficient interfaces with the aircraft body. All this leads to only a limited predictability of the "Earliest Off Block Time", this being an important time constant to trigger the departure and consequently the arrival sequence. This paper reveals the current data quality as found during a large field study at German Airports, derives the reasons for largely varying process times both on the technical and procedural level and shows the potential for improved TAT reliability through aircraft interface optimization.**

Keywords—Aircraft Turn Around, Aircraft Body, Ground Handling, Boarding, Critical Path, Monte Carlo Simulation

Runways Sequences and Ground Traffic Optimisation

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***Abstract*—At the airport level, the new systems involved in the A-SMGCS (Advanced Surface Movement Guidance and Control System) give the possibility to take advantage of some innovative decision support tools bound to the optimisation of the ground traffic management. In this article, two different tasks assumed by airport controllers are analysed and modeled: the runway sequencing process and the application of runways sequences at the ground level. An existing ground traffic simulator is adapted to measure the potential improvements that could be expected by the use of some optimisation methods applied on these two modeled problems.**

TRACK 7

Airlines Operations

Accuracy of Reinforcement Learning Algorithms for Predicting Aircraft Taxi-out Times

(A Case-study of Tampa Bay Departures)

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***Abstract*—Taxi-out delay is a significant portion of the block time of a flight. Uncertainty in taxi-out times reduces predictability of arrival times at the destination. This in turn results in inefficient use of airline resources such as aircraft, crew, and ground personnel. Taxi-out time prediction is also a first step in enabling schedule modifications that would help mitigate congestion and reduce emissions. The dynamically changing operation at the airport makes it difficult to accurately predict taxi-out time. In this paper we investigate the accuracy of taxi out time prediction using a nonparametric reinforcement learning (RL) based method, set in the probabilistic framework of stochastic dynamic programming. A case-study of Tampa International Airport (TPA) shows that on an average, with 93.7% probability, on any given day, our predicted mean taxi-out time for any given quarter, matches the actual mean taxi-out time for the same quarter with a standard error of 1.5 minutes. Also, for individual flights, the taxi-out time of 81% of them were predicted accurately within a standard error of 2 minutes. The predictions were done 15 minutes before gate departure. OOOI data available in the ASPM database maintained by the FAA was used to model and analyze the problem. The prediction accuracy is high even without the use of detailed track data.**

Keywords—taxi-out delay; prediction; reinforcement learning.

Research of the Relation Between the Sustainability of Hourly Capacity at Schiphol Airport, KLM Arrival Punctuality and the Percentage of KLM Transfer Passengers at Risk of Losing their Connection

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Abstract— **Schiphol airport has become one of the major airline hubs in Europe as a result of KLM's growth strategy in the 1980s and 1990s. To provide a high customer satisfaction level, it is of great importance for KLM to provide a highly reliable network. In this paper two performance indicators (PI) are identified to express this reliability: the arrival punctuality according to the KLM timetable and the percentage of KLM transfer passengers at risk of loosing their connection. This research addresses the effect of the performance of the Dutch air navigation service provider (Air Traffic Control the Netherlands – LVNL) on the arrival punctuality and the percentage of KLM transfer passengers at risk of loosing their connection. The contribution of LVNL is expressed in hourly inboud capacity and delays caused by its reduction as well as in terms of the LVNL performance indicator – sustainability of hourly capacity. The study has shown that there is a linear relation between the sustainability of hourly capacity, KLM arrival punctuality and the percentage of KLM transfer passengers at risk of loosing their connection. The relations are derived from the historical data and they are limited to KLM European inbound flights in the second bank of the day (based on the 7 banks system KLM is operating with) when two landing runways were in use. These are made based on sustainability value calculated for the given declared capacity. The derived models can be used for making estimations of arrival punctuality and the percentage of KLM transfer passengers at risk of loosing their connection for a given sustainability. The estimate values have been compared with the actual ones and have shown that the actual values lay well within the confidence interval of the models demonstrating the accuracy of the models. Furthermore, the effect of a reduced hourly inbound capacity on arrival punctuality and the percentage of KLM transfer passengers at risk of loosing their connection has been researched. When the capacity forecast value is higher than demand at Schiphol, LVNL induced delays are low. Values of arrival punctuality and the percentage of KLM transfer passengers at risk of loosing their connection are almost constant for small values of the LVNL influenced delays and therefore do not fluctuate much when the capacity forecast is higher than demand. The relationships found lay the basis for decisions support models and tools for optimizing and further developing the KLM network operations at Schiphol airport.**

Keywords—Schiphol airport, KLM, ATC the Netherlands, LVNL, arrival punctuality, transfer passengers, sustainability of hourly capacity, hourly inbound capacity.

Efficiency of Aircraft Boarding Procedures

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***Abstract*—Efficient boarding procedures are the basis for fast turnaround times. The boarding is an essential part of the critical path of the turnaround process, so time savings directly advance the overall process. Previous research results pointed out that the boarding time can be significantly reduced by using adapted boarding procedures. In this paper we present a comprehensive analysis of boarding procedures (A320-200, 174 passengers) considering different seat load factors, passenger acceptance of chosen boarding order, and arrival rates. The results of the analysis yield a lower boundary for an efficient boarding of approx. 40% acceptance rate, 50% seat load factor and an arrival rate of 7 passengers per minute. Furthermore, the use of the rear door has a substantial effect regarding the boarding efficiency. An enhancement of approx. 25 % is reached, without the disturbing influences of the strategy acceptance rate.**

Keywords—Boarding; Critical path; Efficiency; Turnaround

A Preliminary Evaluation of Potential Cargo Demand for Very Light Jets

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***Abstract*— this paper presents a research effort to study future air cargo demand using new generation Very Light Jets. Cargo demands are generated at county and airport level using T100D and Woods & Poole demographics data. At airport level, a growth factor based FRATAR model is applied to distribute air cargo demand among cargo airports up to year 2025. Historical trends of all-cargo carriers load factors are analyzed. An economics model is built to study Very Light Jet cargo transport cost. Cases studies are conducted to assess the competitiveness of the VLJ in terms of transport time and cost. Throughout our analysis, air cargo is further categorized into freight and air mail as they have different characteristics.**

Keywords—component Very Light Jet, Air Cargo, Growth Factor,Demand Forecast

TRACK 8

Airlines and ATC Concerns

Untapped Potential of On-Board Advertising

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***Abstract*— Today advertisements can be seen everywhere, on the seats of grocery carts, on the walls of an airport walkway, on the sides of buses, heard in telephone hold messages and they can even be seen on the fuselage of an aircraft or on-board. On-board advertising recently becomes a significant source of revenues for airlines all over the world. Inspired by ground public transport, air carriers have started to explore a great potential of on-board marketing and advertising. Advertising on-board provides smarter and cost-effective way of communicating with the customer and it is one of the new methods to inform potential customers about products and services and how to obtain and use them. However, compared to other means of transport, the potential of advertising on-board of aircraft seems to be untapped. It is necessary to realise that revenues from on-board advertising can help airlines to keep their competitiveness. Despite the fluctuation of fuel price, airlines will be able to maintain constant fare thanks to revenues from advertising. The main objective of our study is to analyse a real potential of onboard advertising. The study is mainly focused on low-fare airlines as these reach both high fleet utilisation and high load factors. These facts make low-fare carriers being an ideal market for on-board advertising. By means of this study, we would like to answer the question, if Michael O'Leary's dream of no-fare airline can come true in near future or if it is just utopia.**

Keywords—on-board advertising, ancillary revenues, operating costs

Pricing Schemes Based on Air Navigation Service Charges to Reduce En-Route ATFM Delays

Preliminary results

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***Abstract*—In this paper we analyze an incentive scheme based on air navigation service charges modulation that could help in reducing ATFM delays, inducing users to make a better and more uniform use of capacity, especially in those situations in which the distribution of traffic is known to be non homogeneous. A first experiment indicates the feasibility of implementing such a system and further investigations and refinements of the model are going to be performed in the next future.**

Keywords—En-route charges, Air navigation service charges; Incentive schemes; ATFM delays.

Estimation of Aviation Infrastructure Condition from a Biased Sample

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***Abstract*—In this paper, we address the problem of making inferences about a population of infrastructure facilities from a subset that is a biased sample. We consider the case in which the sample is biased towards facilities in worse condition or requiring more expensive repair. Two methods are developed that incorporate a model of the process through which the sample is selected. One of the methods is based on well-known truncated distributions, whereas the other assumes that the bias operates continuously. The methods are applied to a class of facilities under the FAA's jurisdiction known as "un-staffed facilities." These consist of structures housing radars, navigation aids, radio beacons, and other ground-based equipment, and no previous system-wide evaluation has been attempted for these facilities. We present and discuss the estimates obtained from both the methods, and examine their goodness-of-fit with the sample. Given the premise that bias exists, the continuous bias model proved more suitable. However, the continuous bias model did not surpass the truncation models in terms of goodness-of-fit.**

TRACK 9

Environment, Weather & Economy

On the Use of Near Field Computational Fluid Dynamics for Improving Airport Related Dispersion Models

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***Abstract*— This paper discusses one of the major problems concerning current dispersion modelling techniques used around airports; the source dynamics characterization. Due to the lack of information and non-availability of experimental data, common dispersion models rely on very simple source approximations. Through a staged process, the paper shows a more accurate representation of the plume dynamics of an aircraft during the take-off phase. Using Computational Fluid Dynamics, useful data can be collected to represent and understand the fluid mechanics associated with the dispersion process. The results can help dispersion modelers with better source dynamics representation and benefit the management of aircraft time separation delays in the take-off and landing phases.**

Keywords—Source Dynamics; Airports; Take-off; CFD; LIDAR;LES; Buoyant Jets; Ground Effects; Dispersion Models; Air Quality.

Optimal Departure Aircraft Trajectories Minimising Population Annoyance

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***Abstract*—This paper presents a strategy for designing noise abatement procedures aimed at reducing the global annoyance perceived for the population living around the airports. By using fuzzy logic techniques it is shown how annoyance can be modelled in function of the maximum perceived noise level at a specific noise sensitive location and the time of the day when the departure takes place. Thus, the annoyance is computed for different kinds of sensibility areas, such as residential zones, industrial zones, schools or hospitals and an annoyance figure is obtained for each possible trajectory. Then, a non-linear multi-objective optimal control problem is presented in order to obtain the minimum annoyance trajectory for all sensitive locations. Lexicographic optimisation is used to cope with the difficulties that arise when several criteria appear in the optimisation process. Finally, a practical example is given for an hypothetical scenario where different optimal trajectories are obtained at different day periods.**

An Artificial Intelligence Approach to Operational Aviation Turbulence Forecasting

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Abstract— **Turbulence is a major aviation hazard for both commercial and private aircraft. Currently, the clear-air turbulence forecasting tool Graphical Turbulence Guidance (GTG) is used by airline meteorologists and dispatchers for flight planning, and in part to determine operational Airman's Meteorological Information (AIRMET) turbulence advisories; however, GTG has much higher resolution and intensity discrimination than do AIRMETs, providing more pinpointed locations of moderate or greater turbulence. Because numerical weather prediction (NWP) models cannot explicitly predict aircraft-scale turbulence, we use artificial intelligence (AI) algorithms to capture the relationships between large-scale atmospheric conditions and turbulence. This paper provides an overview of GTG and details beginning work for development of the next release of GTG using in-situ turbulence observation data. We apply two AI techniques, support vector machines and logistic regression, to clear-air turbulence prediction. We show improved forecast accuracy over the current product performance, and begin specializing forecasts by geographic region and altitude. We show the algorithms' feasibility as part of a real-time operational turbulence forecasting system.**

An Environmental Airport ATM Modelling Support Tool and its use in Stacking and CDA Scenarios

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Abstract— **Air Traffic Managers increasingly need to consider environmental impacts when planning future operations or reviewing current procedures, particularly in relation to noise and emissions. In response to this need an environmentally aware Air Traffic Management (ATM) modelling tool has been designed and implemented in the context of the Environmentally Friendly Airport ATM Systems (EFAS) Project. This paper focuses specifically on the support environment provided by the ATM modelling tool and how it was used to inform the decision making process in an example case study examining the impact of various amounts of stacking on the environmental efficiency of Continuous Descent Approaches (CDAs). It is found in a pessimistic scenario, (where no delay is absorbed 'up-stream'), traffic arriving at a medium sized UK airport subjected to increasing traffic levels, (from 2004 out to 2030), experience exponentially growing stacks. In a 2015 timetable scenario, for example, stacks are found to generate approximately 11% more CO_2 and 5% more NO_x than top of descent CDAs alone. This finding underlines, from an environmental perspective, the need for the use of advanced ATM techniques such as Airborne Separation Assistance Systems (ASAS), Arrival Management tools (AMAN) and Collaborative Decision Making (CDM), to produce a set of efficient, deconflicted, flight movements.**

Keywords—Modelling, Stacking, Continous Descent Approaches, Air Traffic Management, Environment, On demand delay.

Analysis of Emissions Inventory for "Single-Engine Taxi-Out" Operations

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***Abstract*—Stringent federal and state programs along with technology innovation have resulted in declining emissions from static sources (e.g. power plants) and are projected to meet national quality standards by 2025. The same cannot be said for mobile sources of emissions from flight operations at airports. In the absence changes in airport operations, the forecast rates of growth in flight operations will jeopardize State's abilities to lower emissions to meet Federal standards. Recent studies indicate that 96% of flights in the U.S. accrue their delays at the airports and directly impact local nonattainment through emissions. This paper examines the sensitivity of emission factors (number of engines, engine efficiency and fleet mix, taxi-out time) through a case-study of departure operations at Orlando (MCO) and New York- LaGuardia. Under the assumptions of a representative fleet mix, departure schedule, runway assignment, and taxi flows, "feasible single engine" taxi-out procedures reduced emissions (CO/NOx/SOx/HC) by 27% at MCO and 45% at LGA. To achieve the same level of emissions reduction requires a 25% decrease in taxi-out time at MCO, and 44% decrease at LGA. The implications of these results on optimization of surface operations to minimize emissions are discussed.**

Keywords—component; emissions, noise, surface optimization, single engine, taxi, fuel, pollution, environment.

On the Use of Visualization Tools to Present Complex Simulated Environmental Data for Policy Making

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***Abstract*—The future of aviation is the subject of considerable debate and policy discussion. There is also increasing emphasis on the inclusion of public consultation and participation within the planning and decision making system. Yet, presenting the findings of complex, multi-dimensional research in a style that is accessible by a potentially lay audience is no simple challenge. This is especially true for subjects whose findings are controversial, such as airport expansion plans and possible health implications of activities. Text heavy**

documents laden with equations, graphs and tables will in most cases act only to alienate a non-expert. However, a method that has found favor in presenting to the non-expert is the use of visualizations, particularly visualizations that allow for a degree of interactivity. This paper investigates a number of the barriers that exist between science and policy making, and then proposes the virtualization application Google Earth as ideally suited for presentation of aviation-related subjects. The paper includes examples of Google Earth models which make use of the 3D capabilities of the tool combined with streamed geographical content to provide stakeholders with a novel, intuitive and interactive presentation that requires no expert understanding to convey its findings.

Keywords—Environmental policy, aviation, visualization,science-policy divide, lay audience, Google Earth

Peak Oil, Fuel Costs and the Future of Aviation

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Abstract—**This research investigates the impact of global oil production peak transmitted via soaring fuel prices on future air traffic. The paper analyzes the short-term impact of higher fuel prices on airline operating costs, passenger fares and demand for short-haul and long-haul services. Results indicate that the rate of air traffic growth constrained by scarcity of kerosene is much lower - and may even be negative - than unconstrained air traffic growth. Services offered by low-cost carriers and long-haul services are most adversely affected. It is also contended that a strong increase in fuel prices outweighs the potential impact of proposed emission trading systems for the aviation industry. Looking beyond the peak in oil production the paper provides a brief discussion of potential substitutes for petroleum kerosene as jet fuel.**

Keywords—environment; peak oil; airline operating costs; air fares; traffic growth

Analysis of Air Transportation for the New York Metroplex: Summer 2007

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Abstract—**The New York metroplex airports (JFK, LGA, EWR) provide air transportation service to this critical international economic hub. In the summer of 2007 the flights servicing the NYC metroplex airports experienced excessive delays and cancellations that added significant costs to doing business in New York. These delays can be attributed to changes in daily airport capacity (due to weather) and to airline practices, in accordance with regulations, of scheduling in excess of airport capacity. Previous research has demonstrated that maintaining airline seat capacity by increasing aircraft size and reducing frequency is an economically efficient and feasible solution. This paper analyzes the characteristics of the air transportation service to the New York metroplex airports. The metroplex has service to 104 domestic airports. 36.5% of airports serve all three New York airports, while 35.6% serve two of the airports. For all the routes to NYC, the average number of flights per day is 6 with a maximum of 32. These routes have an average aircraft seat size ranging from 19 to 238 with an average of 94 seats per flight. These routes had passenger load factors ranging from 0.26 to 0.95 with an average of 0.78. This yields an average of 281 unused seats per day on these routes. Additional statistics and discussion of these results on the implications for consolidation of service with larger aircraft and reduced frequency is discussed.**

Keywords—JFK; LGA; EWR; metroplex; air transportation

Doctoral Consortium

Demand for Low-Cost Airlines in Australia

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***Abstract* — the purpose of this study was analysis of low-cost airline demand in Australia. As part of this project, an econometric method was applied to develop a regression model for forecasting demand. The research hypothesis being that lowcost airline demand in Australia is based on the following variables: domestic airfares, price of other transport modes, population, disposable income and tourist numbers. It was found that demand for low-cost airlines is primarily a function of domestic airfare and population while tourist numbers and price of other transport modes did not have a significant influence.**

Keywords—low cost airlines; demand modelling

Information Design for Collaboration in Distributed Team Work

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***Abstract*—This paper describes a doctoral research plan on collaborative practices in ATC. The research is in its early phase and intends to investigate ATC collaborative practices under the Target Time of Arrival Project currently under development at EUROCONTROL. Expected outcome will fall in the area of display design and/or validation. Current efforts are allocated to a review of theories and models that characterize human activities in relation to the context. Such review will inform later data collection and design phases.**

Keywords—component: human factors; collaborative work; distributed team work; target time of arrival (TTA) concept.

Optimising the Predictability and Flexibility of Dynamic System: Case of 4D Aircraft Trajectory of Air Traffic Management

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***Abstract*—The 4D trajectory is envisioned as the kernel of the future Air Traffic Flow Management system. In this research, we propose an approach dealing with the predictability and flexibility of the system using 4D trajectory. A mix integer programming problem is proposed to minimize the deviation from actual flown 4D trajectory in relationship to the reference trajectory.**

Keywords—Air Traffic Flow Management, 4D Trajectory, mix integer programming.

The Integrator Market

Actors and Their Strategies

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***Abstract*— Integrators – companies that offer vertically integrated, time-definite, door-to-door transport – have a significant market power. However, insight into the market structure and the cost structure of these companies, as well as into the consequences of their expansion and cooperation strategies, is lacking. The purpose of this paper is to analyse the integrator market from an organizational perspective, describing the strategic behaviour of the market participants. This paper provides a clear insight into the major actors of the integrator market and their expansion and cooperation strategies.**

Keywords—Integrators; strategic behaviour; expansion; cooperation; industrial economics

A Construction Rationale to Tailor Crew Resource Management Training to Target Audiences

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Abstract— **This paper gives an overview on the first steps of a 3-year Crew Resource Management and Human Factors training project. A construction rationale consisting of a training needs assessment phase and of theory driven reflections on training design is presented. For the needs assessment, a careful choice and application of methods to gather information is vital, because this information will form the base of training design. Furthermore, a learning theory (instance-based learning theory), training methods, legal requirements and training strategies (cross training, guided team self-correction and team coordination and adaptation training) as well as their contributions to training design are described. The intention to generate a training theory and the development of a classification of training methods along the criteria knowledge, skills and attitudes and theory- or experience-based learning are presented.**

Keywords—Crew Resource Management; Teamwork; Teamtraining; Human Factor; Needs Assessment; Training Theory

Technology Assessment and Prioritization for Small and Medium Airports: A Methodological Approach

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Abstract—**The air transportation industry is a significant source of employment for millions of people around the world. It is also an indispensable part of the economic infrastructure and as such, the gridlock experienced and forecast at large airports may have major negative impacts on the economy. This research aims to address the increase in demand and resulting capacity issues by considering the implementation of operational concepts and technologies at underutilized airports. The objectives of this work are primarily to off-load the busiest airports by increasing operations at smaller airports, reduce door-step to destination travel time, and provide transportation alternatives. More particularly, this work proposes a methodology to help in the assessment and prioritization of equipment packages and technologies necessary to enable that increase in operations. By associating multi-criteria technology selection techniques to ongoing small airport simulation effort, this work aims at helping airport managers make more informed decisions with regards to equipment offers in order to meet their future technological needs.**

Evaluating Aeronautical Regulations Using Rigorous Specifications

Safeguarding against unintended consequences

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***Abstract*—The purpose of this thesis project is to present an innovative methodology (consisting of methods, tools and procedures) which seeks to improve the rulemaking processes currently used to develop aeronautical safety and security regulations. The two main contributions of this methodology are: its use of rigorous methods and tools to help improve the regulation's validation process and its capacity to help identify the impact of proposed amendments on enacting regulation (while helping mitigate regressions).**

Keywords—Rigorous modeling, Very Light Jet, aeronautical regulations, safety, security.