CONFERENCE PROGRAMME

Flight Simulation Conference

MODELLING AND SIMULATION IN AIR TRAFFIC MANAGEMENT

DAY ONE - TUESDAY 14 NOVEMBER 2017

08:30 **Registration and Refreshments**

09:00 **WELCOME & OPENING REMARKS**
Speaker: *John Cook, Director, Parydon Limited and Conference Chairman, Flight Simulation Group, Royal Aeronautical Society*

09:10 **KEYNOTE ADDRESS**
Speaker: *Dr Tom Edwards, Chief Technology Officer, Crown Consulting Inc*

SESSION ONE: MODELLING AND SIMULATION TO ENABLE CAPABILITY DEVELOPMENT IN ATM
Chairman: *TBC*

09:30 **1) FAST-TIME MODELING AT THE U.S. FEDERAL AVIATION ADMINISTRATION**
The U.S. Federal Aviation Administration (FAA) is the largest Air Navigation Service Provider in the world, providing air traffic control services for five million square miles of airspace. The FAA is currently engaged in a far-reaching transformation of air traffic management technologies and procedures known as NextGen. In order to analyze the performance of this system-of-systems, evaluate new investment options, and examine the impacts of alternative budget and governance proposals, the FAA relies on a suite of fast-time modeling tools used by many analysts across the organization. These tools span all ATM domains. The presenter will discuss the tools that are currently used at FAA, the problems they are used to address, and future challenges for the air traffic management modeling community.
Speaker: *Joesph Post, Deputy Director, NAS Systems Engineering and Integration, Federal Aviation Administration*

09:50 **2) DEVELOPMENT OF A HIGH-FIDELITY SIMULATION ENVIRONMENT FOR SHADOW-MODE ASSESSMENTS OF AIR TRAFFIC CONCEPTS**
This presentation describes the Shadow Mode Assessment Using Realistic Technologies (SMART-NAS) Test Bed. The SMART-NAS Test Bed is an air traffic simulation platform being developed by the National Aeronautics and Space Administration (NASA). The SMART-NAS Test Bed's core purpose is to conduct high-fidelity, real-time, human-in-the-loop and automation-in-the-loop simulations of current and proposed future air traffic concepts for the United States' Next Generation Air Transportation System called NextGen. The principle concepts to be simulated include advanced gate-to-gate, trajectory-based operations, widespread integration of novel aircraft such as unmanned vehicles, and real-time safety assurance technologies to enable autonomous operations. This presentation describes the SMART-NAS Test Bed's purpose; its concept of use; and the resulting benefits, key capabilities, high-level requirements, architecture, software design and software builds.
Speaker: *Alan Lee, SMART-NAS Test Bed Deputy Technical Lead, NASA*

10:10 **3) SIMULATED SWIM (SYSTEM WIDE INFORMATION MANAGEMENT) SERVICES IN ATM**
This paper seeks to present the concept of System Wide Information Management (SWIM) in ATM, to outline real

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and potential use cases for simulated services across the solution lifecycle; to describe an approach to simulating a SWIM environment using a Service Oriented Architecture, and to report our experiences of simulating SWIM services. Using simulated SWIM services, we have been able to create and run complex operational scenarios including many different types of ATM stakeholders with only a few systems. We have successfully used a mix of existing, simulated and prototype systems from different vendors, leading to cost and time efficient development and validation exercises. We have also been able to demonstrate the value of SWIM and new operational concepts to key decision makers to get funding and support for future development and implementation activities.
Speaker: *Niklas Häggström, Senior Consultant, Knowledge Agency*

10:30 **4) EVOLUTION OF A SIMULATION TESTBED INTO AN OPERATIONAL TOOL**
This paper describes the evolution of the Future Air Traffic Management (ATM) Concepts Evaluation Tool (FACET) from a National Airspace System (NAS) based simulation testbed into an operational system called NAS Constraint Evaluation and Notification Tool (NASCENT). Over two decades of activity is presented, which included application and infrastructure development, and led to its utility as a tool for various functions. FACET was developed as a testbed for assessing futuristic ATM concepts, such as automated conflict detection and resolution, modelling and optimization of traffic flow management, etc. NASCENT is an operational tool for alerting airspace users of inefficiencies in flight operations and advising time and fuel saving re-routes. It is currently in use at the American Airlines Integrated Operations Center in Fort Worth, TX.
Speaker: *Dr Kapil Sheth, Flight Trajectory Dynamics and Controls Branch (AFT), NASA Ames Research Center*

10:50 **Networking Refreshment Break**

11:20 **PANEL DISCUSSION**

SESSION TWO: ATM SIMULATION BASED DECISION SUPPORT TOOLS
Chairman: *TBC*

11:50 **5) ESTIMATING THE IMPACT OF ADS-B ONLY SURVEILLANCE AND PROJECTING BENEFITS AT FUTURE LOCATIONS**
The FAA Surveillance and Broadcast Services Program has successfully installed ADS-B sensors across the US National Airspace System (NAS) for use in Air Traffic Management. In many areas, the surveillance coverage volume for ADS-B is greater than the existing radar coverage. In fact, the current ADS-B surveillance floor extends much lower than radar at over 500 NAS airports. The first part of this study uses actual radar and ADS-B coverage profiles at different altitudes to determine relevant towered and non-towered airports that should receive ADS-B only benefits. The results indicate a significant benefit to the program that was not claimed in the original cost benefit analysis because the difference between the ADS-B and radar coverage volumes was not known. The second part of this study evaluates additional areas where future ADS-B only surveillance would be cost-beneficial. The potential benefits for each grouping was calculated to define optimal sets. The potential benefits were then compared to costs to estimate cost-beneficial locations for future surveillance.

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Speaker: *Dr Dan Howell, Senior Operations Research Analyst, Regulus Group*

12:10 **6) ADAPTIVE AERIAL ECOSYSTEM GENERATION FOR TACTICAL CONFLICT MANAGEMENT RESOLUTION PROCESS**

This paper elaborates an innovative automation-based concept in future design of the European ATM system, supporting an irruptive shift from the centrally controlled to a distributed system, in which aircraft create dynamic ecosystems, with self-governed capabilities, to find the most optimal conflict-free resolutions, taking both safety and cost-efficiency into consideration. The approach is seeking for an advanced time horizon, look-ahead time, in which airspace users would have more possibilities to negotiate their resolutions before an ATC directive is issued. The concept is intended to be operable in a highly dense enroute airspace and completely aligned with the Trajectory Based Operations requirements. It deploys several modules for a smooth transition, from trajectory management, separation management, to collision avoidance layer. The airborne and ground-based decision support tools, developed for the ecosystem creation, tracking and resolution process and supported by a multi-agent modelling algorithm, are initially verified with the preliminary simulation results.
Speaker: *Marko Radanovic, Researcher, Universitat Autònoma de Barcelona*

12:30 **Networking Lunch**

13:30 **7) IMPACT OF OPTIMIZED TRAJECTORIES ON THE AIR TRAFFIC FLOW MANAGEMENT**

In this study, the impact of multi-criteria optimized free route trajectories on the ATFM system is estimated with respect to the increased ATC controller taskload, the fuel savings and the change in ATC sector capacity, compared to a reference, radar tracked real air traffic scenario. Therefore, we present a unique combination of the fast time Air Traffic Optimizer AirTOp with multi-criteria optimized trajectories, calculated with the TOolchain for Multicriteria Aircraft Trajectory Optimization TOMATO. A reference scenario of one hour of European's air traffic is simulated and assessed with AirTOp considering real weather input data. Coexistent, the simulated city pairs and the departure times are used to optimize and assess each trajectory in TOMATO with respect to minimum ecological costs due to engine emissions, minimum operating costs and a guaranty of today's safety requirements.
Speaker: *Dr Judith Rosenow, Postdoctoral Researcher, Institute of Logistics and Aviation*

13:50 **8) COLLABORATIVE AIRPORT PASSENGER MANAGEMENT WITH A VIRTUAL CONTROL**
Speaker: *TBC*

14:10 **PANEL DISCUSSION**

SESSION THREE: OPERATIONAL DEVELOPMENT THROUGH MODELLING AND SIMULATION
Chairman: *TBC*

14:40 **9) A FRAMEWORK FOR INTEGRATED TERMINAL AIRSPACE DESIGN**

Route planning and airspace sectorization are two central tasks in ATM. Traditionally, the routing and sectorization

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problems were considered separately, with aircraft trajectories serving as input to the sectorization problem and, reciprocally, sectors being part of the input to the path finding algorithms. In this paper we propose a simultaneous design of routes and sectors for a transition airspace. We compare two approaches for this integrated design: one based on mixed integer programming (MIP), and one Voronoi-based model that separates potential "hotspots" of controller activity resulting from the terminal routes. One of our main technical novelties is the suggestion to abandon the trajectories- to-complexity-to-sectors scheme (the golden standard for sectorization solutions) and instead directly build sectors around the potential conflicts on the routes themselves (eliminating the construction themselves (eliminating the construction of the complexity map). We apply our two approaches to the design of Stockholm TMA.
Speaker: *Dr Christiane Schmidt, PostDoc, Linköping University*

15:00 **10) TOWARD THE CHARACTERISATION OF SEQUENCING ARRIVALS**
This presentation focus on a novel approach, essentially data driven, to understand and characterise the sequencing of arrivals in the approach area, assessing the level of similarity of controllers' actions in response to given traffic situations.

A first case study is presented, applied to different sequencing techniques (a baseline and two new ones), using track data from humans to in the loop simulations, to demonstrate the approach capability in characterising the sequencing work, notably in terms of convergence speed toward the final sequence position, suggesting that the sequencing is anticipated and performed earlier for some of these techniques.

A second application to a series of selected busy European TMAs, using actual surveillance data over an extended time period, is presented, highlighting sequencing patterns and their level of similarity/dissimilarity.
Speaker: *Raphaël Christien, Data Analysis Engineer, EUROCONTROL Experimental Centre*

15:20 **Networking Refreshment Break**

15:40 **11) MODELING THE IMPACT OF REDUCED SEPARATION ON PILOT ALTITUDE REQUEST BEHAVIOR IN OCEANIC AIRSPACE**
The FAA is examining the benefits of reduced oceanic separation in US-controlled airspace. A primary benefit involves accommodation of pilot altitude requests. Input from the airlines indicated that reducing separation would also likely influence pilots to ask for more altitude requests. To test if such behavior change was reasonable, a study was performed to examine altitude request trends before and after previously approved separation reductions in US-controlled oceanic airspace. The results indicate that pilot altitude requests per flight from properly equipped flights increased by 10 to 15 percent depending on the airspace examined. The second part of the study examines how the pilot request behavior was used to tune parameters in the FAA NextGen Global Oceanic Model (GOM) and how those parameters impact the number of climb requests made and granted, as well as the resulting fuel burn and fuel burn savings produced by the model.
Speaker: *Rob Dean, Operations Research Analyst, Regulus Group*

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16:10 **12) ON-DEMAND ASSESSMENT OF AIR TRAFFIC IMPACT OF BLOCKING AIRSPACES**
Demand for airspace access has been on the rise due to an increasing number of new entrants such as Space Operators, Unmanned Aircraft Systems (UAS), and Balloon Operators. To accommodate operations such as space launches in the National Airspace System (NAS), the Federal Aviation Administration (FAA) may block air traffic from strategically located airspaces to ensure operational safety. This briefing presents a prediction model coupled with a "what-if" analysis capability, whereby changes in airspace dimension, location and activation time are reflected instantaneously as measures of projected impact. There are three key components of this work: developing a model that uses historical data to predict air traffic demand, modelling air traffic impact from rerouting or delaying the affected traffic, and finally reducing this information to a data structure that can support on-demand analysis. The focus of this research is the new techniques developed to predict demand from a large set of historical track data and further encode these projections to support the quick assessment of the impact of blocking arbitrary airspaces
Speaker: *Amal Srivastava, Software Systems Engineer Lead, MITRE Corporation*

16:30 **PANEL DISCUSSION**

17:00 **CLOSING REMARKS**
Speaker: *John Cook, Director, Parydon Limited and Conference Chairman, Flight Simulation Group, Royal Aeronautical Society*

17:15 **END OF DAY ONE**

18:00 **CAPT RAY JONES LECTURE**
Speaker: *Jeffery Schroeder FRAeS, Chief Scientific and Technical Advisor, Federal Aviation Administration*

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08:30 **Registration and Refreshments**

09:00 **WELCOME & OPENING REMARKS**
Speaker: *John Cook, Director, Parydon Limited and Conference Chairman, Flight Simulation Group, Royal Aeronautical Society*

09:10 **KEYNOTE ADDRESS**
Speaker: *David Parkinson, Independant*

SESSION FOUR: MODELLING FOR AIR TRAFFIC MANAGEMENT OPTIMISATION
Chairman: *TBC*

09:30 **13) FAST-TIME SIMULATION IN SUPPORT OF INTEGRATED DEMAND MANAGEMENT**
Integrated Demand Management (IDM) is a near- to mid-term NASA concept that will contribute to future user-negotiated routing of aircraft to enable the flexible management of aircraft and National Airspace System (NAS) resources based on reliable predictions of future states. A number of Human-In-The-Loop (HITL) simulation studies, with experienced air traffic controllers, have been carried out at the NASA Ames Airspace Operations Laboratory (AOL) to verify and develop the IDM concept. These experiments have produced important results, but are by nature limited because of the resources and time required. A fast-time simulation capability is therefore required that closely mimics the HITL simulation capabilities, while automating both the human components and collaboration between operational systems, and speeding up the real-time aircraft simulations. This presentation describes the development of such a fast-time simulation capability to support IDM.
Speaker: *TBC, Senior Scientist, NASA*

09:50 **14) MODELLING AND SIMULATING AIRPORT SURFACE OPERATIONS WITH GATE CONFLICTS**
The Surface Operations Simulator and Scheduler (SOSS) is a fast-time airport surface operations simulator used to develop and test future surface scheduling concepts. SOSS simulates an aircraft moving through a network of surface taxiways between gates and runways, conforming to separation rules and release commands produced by a surface scheduler. Charlotte Douglass International Airport (CLT)) is a challenging airport surface to both model and operate, due to complex runway operating constraints, limited area in which to taxi, and tightly spaced arrival/departure demand banks that maximize the use of limited gates. This paper discusses how SOSS models each of the challenges associated with CLT surface operations. Particular focus is given to gate conflict management and how it integrates with schedulers that meter departure releases from gates. Several approaches to managing gate conflicts with departure metering were simulated with SOSS and their effects on surface operations are compared.
Speaker: *Shannon Zelinski, Resarch Scientist, NASA Ames Research Center*

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10:10 **15) REAL TIME TOWER SIMULATION FOR VALIDATION OF NEW SYSTEMS AND PROCEDURES**
Often Tower Systems and/or new operating procedures are introduced without taking due cognisance of local operating procedures and peculiarities. This often leads to frustration, inefficiencies, significant costs and even rejection of the system. Careful preparation of a new system can much improve the speed and success of the introduction.
Speaker: *Peter Hardie, Director, ATRICS Advance Traffic Solutions GmbH*

10:30 **16) TBC**

10:50 **Networking Refreshment Break**

11:20 **PANEL DISCUSSION**

SESSION FIVE: SIMULATION OF ATM THREATS AND MITIGATIONS FOR MANNED AND UNMANNED OPERATIONS
Chairman: *TBC*

11:50 **17) COLLISION RISK ASSESSMENT METHODOLOGY FOR PARALLEL APPROACH OPERATIONS**
Towards a collision risk model for PBN based parallel approach procedures, in a first step, a baseline scenario covering state-of-the-art approach environments (vectors onto final, straight-in ILS approach, 3 NM lateral / 1,000 ft vertical separation between aircraft on adjacent tracks) has been modelled. It puts special focus on so called blunder situation where aircraft deviate from their intended flight path for other reasons than navigation tolerances (e.g. due to human error). While existing models focus exclusively on the final approach segment and collisions with ground obstacles (e.g. ICAO CRM), the presented Collision Risk Model covers additionally the intermediate approach including the intercept on final approach track, as this intersection point is known as typical hotspot at busy airports. A Monte-Carlo simulation has been implemented to handle the stochastic model and integrate the various probability functions.
Speaker: *Stanley Foerster, Research Associate, Institute of Logistics and Aviation*

12:10 **18) A SOLUTION FOR TRAJECTORY PREDICTION OF SMALL UNMANNED AIRCRAFT BY EXPLOITING ARTIFICIAL NEURAL NETWORKS**
Future scenarios envisage the use of small UAS within intense traffic systems. Consequently, trajectory prediction tools are needed to allow the traffic control system for a safe time-frame to predict separation and collision threats. It is necessary to develop a method able to predict trajectories for the different UAS types, behaviour and dynamics, in several weather and wind conditions. This presentation proposes a solution based on the use of Artificial Neural Networks (ANN). ANN can exploit flight data collected when a certain type of UAS executes a pre-assigned flight path to support trajectory prediction in standard traffic scenarios, by using an adaptive model learned during the network training. A method to select an adequate configuration for this model is discussed, so that a fast and accurate solution is determined because negligible residuals

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were left. To derive the ANN model, an extensive test campaign has been executed to acquire significant experimental data.
Speaker: *Rita Fontanella, Department of Industrial Engineering, University of Naples Federico*

12:30 **Networking Refreshment Lunch**

13:30 **19) TBC**

13:50 **20) EVOLUTION OF A DISTRIBUTED LIVE, VIRTUAL, CONSTRUCTIVE ENVIRONMENT FOR HUMAN IN THE LOOP UNMANNED AIRCRAFT TESTING**
NASA's Unmanned Aircraft Systems Integration in the National Airspace System Project is conducting human in the loop simulations and flight testing intended to reduce barriers associated with enabling airspace access for unmanned aircraft without the need for a waiver. The primary focus of these tests is studying the interaction of the unmanned aircraft pilot with the display presentation of the detect and avoid alerting and guidance information. The project's integrated test and evaluation team was charged with developing the test infrastructure. In order to accommodate the rapid prototyping and open-ended nature of the research, a distributed test environment was developed incorporating Live, Virtual, Constructive, (LVC) concepts. The LVC components form the core infrastructure support simulation of unmanned aircraft operations by integrating live and virtual aircraft in a realistic air traffic simulation environment. Using standard LVC concepts enable future integration with existing simulation infrastructure.
Speaker: *James R. Murphy NASA Ames Research Center*

14:10 **PANEL DISCUSSION**

SESSION SIX: HUMAN FACTORS, TRAINING AND SIMULATION FOR ATM
Chairman: *TBC*

14:40 **21) PROGRESS WITH SIMULATING THE ATC ENVIRONMENT IN FLIGHT SIMULATORS**
This presentation will provide a brief introduction to SATCE, with an overview of the potential training benefits, and a focus on the potential impact on training non-technical skills and human factors.
New video material from a pioneering trial at Atlantic Flight Training Academy (AFTA), Ireland's largest independent flight training organisation, of Quadrant's automated SATCE solution in a latest-generation high fidelity fixed-base device manufactured by Multi-Pilot Simulations (MPS) of The Netherlands will be presented along with initial findings to date.
A brief update on SATCE industry guidance concerning FSTD and training requirements will also be provided, with a look ahead at the key challenges and future potential this new training technology could provide to the industry.
Speaker: *Jeremy Goodman MRAeS, Senior Manager, Product Development, MicroNav*

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15:00 **22) PRACTICAL CONSIDERATIONS IN FLIGHT TRAINING EVOLUTION WITH SATCE**
Simulated ATC environments for flight simulation offer tremendous opportunity for improving training realism and repeatability. In practice, the problem space presents a new set of challenges when it comes to defining simulator requirements, updating training curricula, and defining instructor workflows. This presentation provides insights based on 3-years of practical experience with SATCE enabled training. We suggest a set of topics for simulator manufacturers and flight training centers to consider when evaluating and running a SATCE solution. To close, we offer some thoughts on how SATCE can improve pilot training in this time of growing air traffic density, high demand for new pilots and evolving air traffic management systems.
Speaker: *Chris Kubek, ASTi USA*

15:20 **Networking Refreshment Break**

15:20 **23) HOW EYE TRACKING DATA CAN ENHANCE HUMAN PERFORMANCE IN TOMORROW'S COCKPIT.**
A good candidate for the on-line recording of pilots' workload and situation awareness are eye tracking data (Biella et al., 2005; Manske, 2015). First results from a flight simulator study with ten flight crews in the project "Human Performance Envelope" of the programme Future Sky Safety funded by the European Commission's Horizon 2020 initiative will be presented. Gaze fixation and fast eye movements were measured in order to gain online insight for the flight crew's situation awareness level 1 "perception". Furthermore, the pupil diameter was measured to identify pilot's workload.
The results of this study will show how to increase the Human Performance Envelope to improve both performance and safety.
Speaker: *Marcus Biella, Researcher, German Aerospace Center*

15:50 **24) BLUESKY - THE OPEN AIT TRAFFIC SIMULATOR**
This presentation is an update on the status of an open source ATM simulation project, which has started in 2013. The project uses a radically open approach: it is trying to achieve a high-fidelity simulation using only license free, 100% open data and free development tools, which allow customized additions e.g. via plug-ins. The resulting traffic simulation program BlueSky is downloadable from Github (google 'profhoekstra bluesky') which includes a Wiki for help. BlueSky runs stand-alone on Windows, Apple and Linux and is currently used and co-developed by several parties in different countries. The presentation focuses on two aspects: the hurdles taken (and to be taken) in this open data-open source approach, as well as how this could help the ATM community with a scientific approach to ATM innovation. It will also show how you can use, and extend this sim yourself.
Speaker: *Jacco Hoekstra, Researcher, Delft University of Technology*

16:10 **PANEL DISCUSSION**

16:40 **CLOSING REMARKS**
Speaker: *John Cook, Director, Parydon Limited and Conference Chairman, Flight Simulation Group, Royal Aeronautical Society*