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Design and Operational Evaluation of the Traffic Management Advisor at the Ft. Worth Air Route Traffic Control Center

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Summary

NASA and the FAA have designed and developed and an automation tool known as the Traffic Management Advisor (TMA). The system was operationally evaluated an at the Ft. Worth Air Route Traffic Control Center (ARTCC). The TMA is a time-based strategic planning tool that provides Traffic Management Coordinators and En Route Air Traffic Controllers the ability to efficiently optimize the capacity of a demand impacted airport. The TMA consists of trajectory prediction, constraint-based runway scheduling, traffic flow visualization and controllers advisories. The TMA was used and operationally evaluated for forty-one rush traffic periods during a one month period in the Summer of 1996. The evaluations included all shifts of air traffic operations as well as periods of inclement weather. Performance data was collected for engineering and human factor analysis and compared with similar operations without the TMA. The engineering data indicates that the operations with the TMA show a one to two minute per aircraft delay reduction during rush periods. The human factor data indicate a perceived reduction in en route controller workload as well as an increase in job satisfaction. Upon completion of the evaluation, the TMA has become part of the normal operations at the Ft. Worth ARTCC.

Introduction

The growth of commercial air travel within the United States has put a severe strain on the nation's air traffic capacity. This coupled with the "Hub & Spoke" procedures used by the major air carriers and the marketing requirements to take-off and land at optimum times has led to the need to improve the Air Traffic Control System. There are two ways to increase the capacity of the system. The first is the building of more runways. Though this might be the obvious solution, the economic and political difficulties make this an undesirable solution for most airports and communities. The second is the addition of decision support automation that allows the capacity to be more efficiently utilized. The Center-TRACON Automation System (CTAS) is a decision support concept being developed to improve airport capacity and reduce delays while maintaining controller workload at a reasonable level[1].

CTAS is comprised of three major decision support tools: the Traffic Management Advisor, the Final Approach Spacing Tool (FAST), and the Descent Advisor (DA). The goal of these tools is to assist air traffic controllers efficiently manage and control arrival traffic within the extended terminal area (100 to 500 miles from touchdown to landing). The core element of each tool is the CTAS 4-Dimensional (4D) trajectory synthesis algorithms[2,3]. These algorithms, similar to those used for Flight Management Systems (FMS) for modern equipped commercial air transports, have a demonstrated 20 min. prediction accuracy of approximately 15 sec. root-mean-square error[4]. Each tool is being designed to provide a level of automation and capability that is not dependent on the other tool functions but can work in consort to provide enhanced benefit. The primary capabilities of the TMA are time-based arrival traffic flow visualization, strategic planning based upon aircraft separation and flow rate constraints, and limited tactical ARTCC controller advisories for metering. The capabilities of FAST are to provide landing sequence and runway assignments that assist Terminal Radar CONtrol (TRACON) controllers efficiently manage arrival traffic in the complex terminal environment[5]. The FAST has been operationally evaluated at the Dallas/Ft. Worth airport and demonstrated a 13% increase in airport throughput without a significant increase in controller workload[6]. The DA is being designed to assist en route controllers by generating accurate, fuel-efficient conflict free clearance advisories[4].

This paper will present a technical description of the TMA followed by a description and analysis of the results from the operational evaluation conducted at the Ft. Worth ARTCC during the Summer of 1996.

References

1. Erzberger, H., Davis, T. J., and Green, S. M.:"Design of Center-TRACON Automation System," Proceedings of the AGARD Guidance and Control Panel 56th Symposium on Machine Intelligence in Air Traffic Management, Berlin, Germany, 1993.

2. Erzberger, H., Tobias, L.,: "A Time-BAsed Concept for Terminal Area Traffic Management," Proceedings of the 1986 AGARD Conference, No. 410 on Efficient Conduct of Individual Flights and Air Traffic, Brussels, Belgium, 1986.

3. Slattery, R., Zhao, Y.,: "En-Route Descent Trajectory Synthesis for Air Traffic Control Automation." American Control Conference, Seattle, WA, June 21-23, 1995.

4. Green, S., Vivona, R.,: "Field Evaluation of Descent Advisor Trajectory Prediction Accuracy," AIAA Guidance Navigation and Control Conference, San Diego, CA, July 29 -31, 1996.
5. Davis, T. J., Krzeczowski, K. J., Bergh, C., "The Final Approach Spacing Tool," Proceedings of the 13th IFAC Symposium on Automatic Control in Aerospace, Palo Alto, CA, 1994.

Invited Speakers and Presentation Topics

Presenter	Presentation	Organization
Topic Area I – Conflict Detection and Resolution [Dieudonne/TBD - Rapporteur]		
United States		
Andrews/Welch	Analysis of Workload Implications of Alternative Conflict Resolution Strategies	MIT Lincoln Labs
Bowlin/Watts	Results of the PRAT Tests	AERA, Inc./FAA
Erzberger	Conflict Probing and Resolution in the Presence of Errors	NASA ARC
McFarland/Burnicki	URET Conflict Probe Results	CAASD
Swenson	Design and Field Evaluation of the Traffic Management Advisor	NASA ARC
Wanke	FFES Conflict Probe Results	CAASD
Europe		
Durand	Optimal Conflict Resolution: Theory and Application	CENA
Gerdes	Conflict Detection and Resolution	DLR
Graham	Hamonisation of HMI - the Intuitive Approach	EUROCONTROL
Leroux	ERATO: Cooperative Tools Based on Cognitive Engineering	CENA
Vink & NLR	MTCD/Conflict Probe	NLR/EUROCONTROL
Jorna	HMI for ATM Automation: a European Strategy Towards Technology and Human Factors Validation	NLR
Price	Decision Support Tools–Oceanic HIPS	NATS
Topic Area II – Airborne Separation Systems and Procedures [Drouilhet/TBD - Rapporteur]		
United States		
Corker	Human Factors in an Advanced ATM System and Simulation Studies	NASA ARC
Endsley	Situation Awareness	MIT
Hansman	Human Performance Consideration in Development of ATM	MIT
Lozito	Free Flight and Self Separation from the Flight Deck Perspective	NASA ARC
Mundra	CDTI/ADS-B/TCAS2 Near Term Enhancements	CAASD
Europe		
Casaux	Operational Use of ASAS	CENA
Duong	Initial Results of Investigation into Autonomous Aircraft Concept (FREER-1)	EUROCONTROL
Linberg/Nilsson	CDTI - ADS/B Experiments	SAS/Swedavia
Onken	CASSY	Univ. der Burdeswehr
Topic Area III – ATM Performance Indicators [Odoni/TBD - Rapporteur]		
United States		
Haraldsdottir	CNS/ATM Focus Team Results: A Global Review of ATM System Modernization Options	Boeing
Odoni	Comparisons of ATM Philosophies in the U.S. and Europe	MIT
Wieland	Limits to NAS Growth: DPAT Results	CAASD
Europe		
Alliott	An Experimental Study of ATM Capacity	CENA
ATMDC	ATM Metrics	NATS
Lenoir	ATC Economic Modelling	ENAC
Manchon	Cost of ATFM	CENA
NLR	Airport Traffic Modelling	NLR
Nightingale	Flow Management Performance Indicators	DLR
Pomeret/Mahlich	ATM Performance Indicators	EUROCONTROL
Tosic	Some Models & Algorithms for En-Route Air Traffic Flow Management	Faculty Transport & Traffic Engrng/Belgrad

Preparation of Material for the US/Europe ATM R&D Seminar

Please submit an abstract of the paper you are planning to prepare and present at the seminar by **February 14, 1997**. The abstract should be brief, yet contain sufficient detail for the reader to understand the subject matter and general results that will be presented. All abstracts will be reviewed by the organizing committee, and final selection of papers and presentations will be made on **February 20, 1997**. You will be notified thereafter of the acceptance of your paper, along with any questions or concerns the committee has regarding the content or scope of the paper. Submission of an abstract will also be interpreted as an initial indication of your willingness and availability to participate in this seminar.

Please disseminate your abstract as an attachment to an e-mail message to both of the points of contact designated at the bottom of this page. If possible, prepare the abstracts using Microsoft Word 6.0, although other standard word processing programs that can be converted to Word 6.0 documents will be accepted.

Following approval of your abstract, please confirm your intention to participate in the seminar with the above points of contact by **March 30, 1997**, to allow the organizers to prepare a final agenda for the seminar.

In order to facilitate the distribution of material at the seminar, it is requested that you provide electronic copies of your completed paper to the appropriate point of contact by **June 1, 1997**. You may attempt to forward these materials as e-mail attachments, but please also mail a disk containing an electronic copy in the event that the e-mail distribution fails. U. S. contributors should mail material to the U. S. point of contact, and European contributors to the European point of contact. If you are unable to provide the paper by the deadline in electronic form, you will be required to bring 50 copies of your paper for distribution at the seminar. Please bring a clean hard copy of your presentation to the seminar for copying and distribution after the meeting.

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