FINAL TECHNICAL REPORT FOR
NASA AMES RESEARCH CENTER GRANT
NAG 2-716

SITUATIONAL AWARENESS ISSUES IN THE IMPLEMENTATION OF DATALINK

Shared Situational Awareness in the Joint Flight Deck-ATC Aviation System

Grant Period: Jan. 1, 1991 - Sept. 30, 1999

PRINCIPAL INVESTIGATOR

Robert John Hansman, Jr.

Professor of Aeronautics and Astronautics
Director, MIT International Center for Air Transportation
Department of Aeronautics and Astronautics
Massachusetts Institute of Technology
Cambridge, MA 02139

rjhans@mit.edu
(617) 253-2271

Technical Summary

MIT has investigated Situational Awareness issues relating to the implementation of Datalink in the Air Traffic Control environment for a number of years under this grant activity. This work has investigated:

- The Effect of "Party Line" Information.
- The Effect of Datalink-Enabled Automated FMS on Flight Crew Situational Awareness.
- The Effect of Cockpit Display of Traffic Information (CDTI) on Situational Awareness During Close Parallel Approaches.
- Analysis of Flight Path Management Functions in Current and Future ATM Environments.
- Human Performance Models in Advanced ATC Automation: Flight Crew and Air Traffic Controllers.
- CDTI of Datalink-Based Intent Information in Advanced ATC Environments.
- Shared Situational Awareness between the Flight Deck and ATC in Datalink-Enabled Environments.
- Analysis of Pilot and Controller Shared SA Requirements & Issues.
- Development of Robust Scenario Generation and Distributed Simulation Techniques for Flight Deck – ATC Simulation.
- Methods of Testing Situation Awareness Using Testable Response Techniques.

The work is detailed in specific technical reports that are listed in the following bibliography, and are attached as an appendix to the master final technical report.

Publications Supported by NASA Grant No. NAG 2-716

Journal Articles and Conference Papers:

1. Davison, H., and Hansman, R.J., "The Effect of Shared Information on Pilot/Controller and Controller/Controller Interactions," (to be presented) FAA/Eurocontrol 3rd International Air Traffic Management R&D Seminar (ATM-2000), Napoli, Italy, June 2000.

2. Hansman, R.J., "The Effect of Shared Information on Pilot/Controller and Controller/Controller Interactions," Workshop on Advanced Technologies and their Impact on Air Traffic Management in the 21st Century (ATM '99), Capri, Italy, September 1999.

3. Endsley, M., Hansman, R.J., and Farley, T., "Shared Situation Awareness in the Flight Deck-ATC System," IEEE AES *Systems Magazine*, **14**, No. 8, 25-30, August 1999.

4. Barhydt, R., and Hansman, R.J., "Experimental Studies of Intent Information on Cockpit Traffic Displays," *AIAA Journal of Guidance, Control, and Dynamics*, **22**, No. 4, 520-527, July-August 1999.

5. Farley, T., Hansman, R.J., Endsley, M., and Amonlirdviman, K., "The Effects of Shared Information on Pilot-Controller Situation Awareness and Re-Route Negotiation," Tenth International Symposium on Aviation Psychology, Columbus, OH, May 1999.

6. Hansman, R.J., Endsley, M., Farley, T., Vigeant-Langlois, L., and Amonlirdviman, K., "The Effect of Shared Information on Pilot/Controller Situation Awareness and Re-Route Negotiation," FAA/Eurocontrol 2nd International Air Traffic Management R&D Seminar (ATM 98), Orlando, FL, December 1998.

7. Endsley, M., Hansman, R.J., and Farley, T., "Shared Situation Awareness in the Flight Deck - ATC System," 17th IEEE/AIAA Digital Avionics Systems Conference, Seattle, WA, October–November 1998.

8. Amonlirdviman, K., Farley, T., Hansman, R.J., Ladik, J., and Sherer, D., "A Distributed Simulation Facility to Support Human Factors Research in Advanced Air Transportation Technology," 1998 Fall Simulation Interoperability Workshop, Orlando, FL, September 1998.

9. Pritchett, A., and Hansman, R.J., "Pilot Non-Conformance to Alerting System Commands During Closely Spaced Parallel Approaches," 16th AIAA/IEEE Digital Avionics Systems Conference, October 1997.

10. Pritchett, A., and Hansman, R.J., "Pilot Non-Conformance to Alerting System Commands," Ninth International Symposium on Aviation Psychology, April 1997.

11. Pritchett, A., and Hansman, R.J., "Experimental Studies of Pilot Performance at Collision Avoidance During Closely Spaced Parallel Approaches," Ninth International Symposium on Aviation Psychology, April 1997.

12. Barhydt, R., and Hansman, R.J., "Experimental Studies of Intent Information on Cockpit Traffic Displays," Ninth International Symposium on Aviation Psychology, April 1997.

13. Pritchett, A., and Hansman, R.J, "Variations Among Pilots from Different Flight Operations in Party Line Information Requirements for Situation Awareness," *Air Traffic Control Quarterly*, **4**, No. 1, 29-50, January 1997.

14. Pritchett, A., and Hansman, R.J., "Experimental Study of Collision Detection Schema Used by Pilots During Closely Spaced Parallel Approaches," AIAA-96-3762, AIAA Guidance, Navigation and Control Conference, July 1996.

15. Pritchett, A., Barhydt, R., Hansman, R.J., and Johnson, E., "Flight Simulator Testing of Cockpit Traffic Displays Using Robust Situation Generation," AIAA-96-3554, AIAA Flight Simulation Technologies Conference, July 1996.

16. Pritchett, A., Carpenter, B., Asari, K., Kuchar, J., and Hansman, R.J., "Issues in Airborne Systems for Closely Spaced Parallel Runway Operations," 14th AIAA/IEEE Digital Avionic Systems Conference, November 1995.

17. Pritchett, A., Hansman, R.J., and Midkiff, A., "'Party Line' Information Use Studies and Implications for ATC Datalink Communications," (Selected as Best Paper), 14th AIAA/IEEE Digital Avionic Systems Conference, November 1995.

18. Hansman, R.J., Pritchett, A., and Midkiff, A., "'Party Line' Information Use Studies and Implications for ATC Datalink Communications," Fifth International Conference on Human-Machine Interaction and Artificial Intelligence in Aerospace, Toulouse, France, September 1995.

19. Pritchett, A., and Hansman, R.J., "Variations on 'Party Line' Information Importance Between Pilots of Difference Characteristics," Eighth International Symposium on Aviation Psychology, April 1995.

20. Pritchett, A., and Hansman, R.J., "Preliminary Analysis of Pilot Ratings of 'Party Line' Information Importance," Seventh International Symposium on Aviation Psychology, April 1993.

21. Midkiff, A., and Hansman, R.J., "Identification of Important 'Party Line' Information Elements and Implications for Situational Awareness in the Datalink Environment," *Air Traffic Control Quarterly*, **1**, No. 1, 5-30, January 1993.

22. Hahn, E. and Hansman, R.J., "Experimental Studies on the Effect of Automation on Pilot Situational Awareness in the Datalink ATC Environment," SAE-92-2022, SAE Aerotech '92 (Note: also published in SAE special publication SAE-SP-933, *Enhanced Situational Awareness Technology for Retrofit and Advanced Cockpit Design*, October 1992.

23. Midkiff, A., and Hansman, R.J., "Identification of Important 'Party Line' Information Elements and the Implications for Situational Awareness in the Datalink Environment," SAE-92-2023, SAE Aerotech '92 (Note: also published in special publication SAE-SP-933, *Enhanced Situational Awareness Technology for Retrofit and Advanced Cockpit Design*, October 1992.

24. Wanke, C., Kuchar, J., Hahn, E., Pritchett, A., and Hansman, R.J., "A Graphical Workstation Based Part-Task Flight Simulator for Preliminary Rapid Evaluation of Advanced Displays," SAE-92-95TI, SAE Aerotech '92, October 1992.

25. Hansman, R.J., Wanke, C., Mykityshyn, M., Kuchar, J., Hahn, E., and Midkiff, A., "Hazard Alerting and Situational Awareness in Advanced Air Transport Cockpits," ICAS-92-3.9.4, 18th ICAS Congress, Beijing, China, September 1992.

MIT Research Reports:

1. Farley, T., and Hansman, R.J., "An Experimental Study of the Effect of Shared Information on Pilot/Controller Re-Route Negotiation," MIT International Center for Air Transportation Report, ICAT-99-1, January 1999.

2. Endsley, M., Farley, T., Jones, W., Midkiff, A., and Hansman, R.J., "Situation Awareness Information Requirements for Commercial Airline Pilots," MIT International Center for Air Transportation Report, ICAT-98-1, January 1998.

3. Barhydt, R., and Hansman, R.J., "Experimental Studies of the Effect of Intent Information on Cockpit Traffic Displays," MIT Aeronautical Systems Laboratory Report, ASL-97-3, June 1997.

4. Pritchett, A., and Hansman, R.J., "Pilot Non-Conformance to Alerting System Commands During Closely Spaced Parallel Approaches," MIT Aeronautical Systems Laboratory Report, ASL-97-2, January 1997.

5. Pritchett, A., and Hansman, R.J., "Experimental Study of Collision Detection Schema Used by Pilots During Closely Spaced Parallel Approaches," MIT Aeronautical Systems Laboratory Report, ASL-96-1, January 1996.

6. Johnson, E., and Hansman, R.J., "Multi-Agent Flight Simulation with Robust Situation Generation," MIT Aeronautical Systems Laboratory Report, ASL-95-2, January 1995.

7. Pritchett, A., and Hansman, R.J., "Variations of Party Line Information Requirements for Flight Crew Situational Awareness in the Datalink Environment," MIT Aeronautical Systems Laboratory Report, ASL-94-5, May 1994.

8. Midkiff, A., and Hansman, R.J., "Identification of Important 'Party Line' Informational Elements and the Implications for Situational Awareness in the Datalink Environment," MIT Aeronautical Systems Laboratory Report, ASL-92-2, May 1992.

9. Hahn, E., and Hansman, R.J., "An Experimental Study of the Effect of Automation on Pilot Situational Awareness in the Datalink ATC Environment," MIT Aeronautical Systems Laboratory Report, ASL-92-1, May 1992.

Appendix

A Collection of 34 Technical Papers and Reports
Resulting from Work Performed Under
NASA Ames Research Grant NAG 2-716