ATOP-R&D

Human Factors Newsletter # 05-01

December 25, 2004 – January 14, 2005

Technical Note: Sollenberger, R. L., Willems, B., Della Rocco, P. S., Koros, A., Truitt, T. (2004). *Human-in-the-Loop Simulation Evaluating the Collocation of the User Request Evaluation Tool, Traffic Management Advisor, and Controller-Pilot Data Link Communications: Experiment I – Tool Combinations* (DOT/FAA/CT-TN04/28). Atlantic City International Airport, NJ: DOT/FAA William J. Hughes Technical Center.

Executive Summary. The FAA established the Free Flight Program in collaboration with the aviation community to increase capacity (airport and airspace) and improve efficiency (flight times and fuel consumption) while maintaining the current high level of safety. An important goal of the Free Flight Program was delivery of new ATC technologies focused on early benefits to users of the National Airspace System (NAS). These capabilities included the User Request Evaluation Tool (URET), Traffic Management Advisor (TMA), and Controller-Pilot Data Link Communications (CPDLC) as en route controller tools. Under the Free Flight Program, the FAA deployed these tools independently to a limited number of Air Route Traffic Control Centers (ARTCCs) nationwide. As deployment expands to other facilities, all three tools may be collocated at the sector workstation.

Different designers developed URET, TMA, and CPDLC with the assumption that each system would operate independently. As tool deployment expands nationwide, several facilities may eventually receive all three tools. Before this occurs, it is important to identify any potential human factors issues that may arise due to the collocation of these tools at the controller's workstation. For example, will controllers be able to access the information they need quickly without confusing data from different systems? How will controller communications between team members be affected? How will the collocation of these tools change the roles and responsibilities of team members? What new training or procedures may be required? The FAA Free Flight Program Office and the Human Factors Research and Engineering Division (ATOP-R&D) sponsored research to address these important questions.

In this report, we present the first of three human-in-the-loop simulation experiments conducted to evaluate the impact of URET, TMA, and CPDLC collocation on controller workload, situational awareness, and teamwork. The first experiment examined Radar-side (R-side)/Data-side (D-side) controller teams working a high altitude sector using different combinations of the

three tools at a single sector. The second experiment examined controller teams interacting with each other while working a high and a low altitude sector and using all of the tools. The third experiment examined controllers working a high altitude sector alone without a D-side and using all of the tools. We will present the second and third experiments in a subsequent report.

Twelve Air Traffic Control Specialists (ATCSs) from Level 11 and Level 12 ARTCCs nationwide participated in this study. We recruited six participants from ARTCCs where URET is operational and six participants from ARTCCs where TMA is operational. All six ATCSs from the URET facilities were URET current and proficient. However, only five ATCSs from the TMA facilities were TMA current and proficient. The participant who was not TMA qualified received TMA training on our ATC simulator. We trained all twelve participants in CPDLC after arriving at the William J. Hughes Technical Center (WJHTC). Also, all participants received some cross-training in URET and TMA. Each controller team consisted of one TMA-qualified ATCS operating the R-side and one URET-qualified ATCS operating the D-side position.

We conducted the experiment using our high fidelity ATC simulator, the Distributed Environment for Simulation, Rapid Engineering, and Experimentation (DESIREE). DESIREE emulated en route Display System Replacement (DSR) functions and was configured with URET and TMA prototypes, as well as CPDLC Build 1A functionality. We deployed TMA and CPDLC on the R-side Sony 2K monitor and URET and CPDLC on the D-side 21" flat-panel monitor. The CPDLC services were: Transfer of Communications (TOC), Altimeter Setting (AS), Initial Contact (IC), and Menu Text (MT) Messages. The study consisted of three 2-week sessions with a different group of four ATCSs participating in each session. In the first week, controllers completed 18 hours of practice scenarios to become familiar with the generic high altitude sector selected for this simulation and the three tools. In the second week, controllers completed eight test scenarios under experimental conditions with different combinations of URET, TMA, and CPDLC. In a baseline condition, participants controlled traffic without any tools. In other conditions, participants completed scenarios using each tool separately, as well as two and three tools together. We counterbalanced the presentation order of the eight tool combinations to experimentally control for practice effects.

The most important collocation issue identified in this experiment was that controllers had difficulty accessing important information on the D-side display when URET and CPDLC were both operational (i.e., display clutter). Controller ratings indicated that CPDLC caused a great deal of display clutter on the D-side monitor. Neither URET alone nor CPDLC alone caused display clutter. However, both tools in combination made it difficult for D-side controllers to find the information they needed quickly. This was especially true for accessing CPDLC windows, which became covered when controllers used URET. It is important to note the controllers identified this D-side display clutter issue using the D-side CPDLC Computer-Human Interface (CHI) we developed for use in this simulation study. We designed the D-side CHI to be consistent with a "stovepipe" independent deployment of the tools with simple features to help controllers manage the multiple windows associated with each tool. This specific D-side CHI was not intended to be the interface that will be deployed to ARTCCs in the future.

Another collocation issue identified in this experiment was that D-side controllers had to access TMA delay time information from the R-side display. Controllers thought it was important to have TMA information available on the D-side display where it could be easily accessed by D-side controllers. However, controllers were concerned that simply showing the TMA List on the D-side might add to the D-side display clutter.

Controller workload ratings indicated that D-side workload tended to increase when two and three tools were operational. However, D-side workload ratings were only moderate and never reached a high level for the moderate traffic scenarios we used in the simulation. We also examined the number of ground-to-air voice transmissions and airspeed, heading, and altitude changes as additional indicators of controller workload. None of these measures increased greatly with multiple tool use.

In general, controllers rated their situational awareness as very high during the simulation. However, there was a situational awareness issue with the CPDLC TOC service. R-side controllers sent most of the CPDLC TOCs to aircraft. Although D-side controllers did not use the TOC service very often, controllers still expressed concern about not knowing what their team member was doing with CPDLC. Unlike voice communications, there were no audible cues with CPDLC to help controllers maintain situational awareness of their team member's actions. Controllers had to visually monitor the CPDLC Message Out window to know when their team member sent a TOC message. If the CPDLC display was covered by URET, the D-side controller could easily miss a sent message.

Good human factors design principles prescribe that users must have immediate access to important information and that critical information should never be covered. A "stovepipe" independent deployment of these tools will result in impaired access to timely information. The results of this study indicated that better human factors efforts should be made towards integrating the information from URET, TMA, and CPDLC. Even if these systems cannot be entirely integrated, we should explore integrating the displays on the D-side monitor.

This research supports the Administrator's Flight Plan Goal for Increased Safety, Objectives 1 and 7: Reduce the commercial fatal accident rate; Enhance the safety of FAA's air traffic systems. This research also supports the Administrator's Flight Plan Goal for Greater Capacity, Objective 1: Increase capacity to meet projected demand.

Point of Contact: E. Stein, WJHTC

Retirement: Dr**.** Don Sussman, Chief of the Operator Performance/Safety Analysis Division, Volpe NTSC, is retiring after 34 years of service. Dr. Sussman made significant contributions to aviation safety in the National Airspace System and aviation operations. He was also a key contributor to research activities in maritime, automobile and rail safety. We wish him the very best!

ETMS Support for Chicago TRACON: Engineering research psychologists from the William J. Hughes Technical Center's NAS Human Factors Group traveled to Chicago Terminal Radar Approach Control Center (TRACON - C90) to examine usability problems associated with newly deployed monitors for the Enhanced Traffic Management System

(ETMS). Controllers reported difficulty viewing the monitors from the operational controller positions, especially at off-angles. The location, size, and other characteristics of the new monitors were examined and procedures and information needs of Air Traffic and Technical Operations personnel were discussed at length. The most significant issue involved visibility of aircraft on the ETMS Traffic Situation Display (TSD) that are not eligible for a land-and-hold-short operation. Controllers need to identify these aircraft well before they enter the TRACON airspace so they can be routed to an available runway. The routing should not disrupt arrival flow and, ideally, should not require putting the aircraft in a holding pattern. Controllers use the TSD to identify these aircraft while still seated at their radar displays. Given the distance and viewing angle from the radar displays to the TSD, identifying these aircraft could be difficult or create more workload for the controllers. Researchers will develop human factors recommendations for resolving the issue and present these to the ETMS program office. This research activity supports the Administrator's Flight Plan Goal for Increased Safety, Objective Seven: Enhance the safety of FAA's air traffic systems. (K.Allendoerfer, T. Yuditsky, WJHTC)

Risk Analysis Group Submits Plan to Institutional Review Board (IRB): Personnel from the William J. Hughes Technical Center's NAS Human Factors Group provided consulting services to a risk analysis group concerning a research plan that will use FAA maintenance personnel to develop a new error model for aircraft maintenance. The human factors researchers assisted in preparing a test plan and survey format that will fit requirements for IRB processing. The enhanced plan will be submitted for IRB review so that the research can be conducted within the guidelines of FAA Order 9500/25. This research activity supports the Administrator's Flight Plan Goal for Increased Safety, Objective Seven: Enhance the safety of FAA's air traffic systems. (E. Stein, WJHTC)

National Traffic Management Log Capabilities. Research Psychologists from the William J. Hughes Technical Center's NAS Human Factors Group attended a design review for upcoming National Traffic Management Log (NTML) capabilities. They examined proposed human-computer interfaces and evaluated whether the design will adequately support the users' tasks. The NTML will be used by Traffic Management Specialists to record and coordinate requests from aircraft that are not properly equipped to utilize the airspace structure designated for reduced vertical separation minima. This research activity supports the Administrator's Flight Plan Goal for Greater Capacity, Objective 2: Increase or improve airspace capacity in the eight major metropolitan areas and corridors that most affect total system delay. (T. Yuditsky, WJHTC)

Risk Factors: Thomas Nesthus (AAM-510) participated in the 84th Annual Transportation Research Board meeting on January 9, 2005. As a participant in Human Factors Workshop Number 134, "Maximizing Safety, Efficiency, and Quality of Life: Linking the Work and Off-Work Conditions for Transportation Workers through the Application of Human Behavioral Science", he presented "Risk Factors for Air Traffic Control Specialists Commuting to and from Early-Morning and Midnight Shifts". Pearson Chi-square analyses and odds ratio risk estimates of commuting variables (acquired during a comprehensive ATCS shift work and fatigue survey), showed a variably increased reporting of lapses of attention, falling asleep, and near misses to be a function of commuting distance (>20 mi.), roadway type (city, country, highway), and mental

alertness (low vs. high) for terminal/en route and flight service option controllers. Other workshop participants discussed issues regarding maritime work schedules, organizational and economic factors, long distance transport and rail scheduling and fatigue, as well as crew endurance management. Cross-modal working group coordination was discussed as an opportunity to focus on behavioral approaches to work/off-work improvement in safety and quality of life for transportation industry employees.

Dr. Nesthus also met with the human factors technical operations fatigue research sponsor (Beverly Clark) and provided an update on fatigue-related projects. The NTSB Director of Research and Engineering (Dr. Vernon Ellingstad), and members of his staff were provided an overview briefing on the flight inspection office validation research effort concerning the Fatigue Avoidance Scheduling Tool. These research activities support the Administrator's Flight Plan Goal for Safety, Objectives 1 and 7: Reduce the commercial fatal accident rate; Enhance the safety of FAA's air traffic systems. (T. Nesthus, CAMI)

Honors: Rebecca Gray was cited by the Power Services Office Division Manager (Joe Morgan) and awarded a plaque honoring her "significant contribution" for the human factors engineering support she provided to the National Direct Current BUS Program Office. Rebecca provides contract technical support to the ATOP-R&D Human Factors Engineering Program. Congratulations, Rebecca! (G. Hewitt, ATOP-R&D)

More information on human factors research can be found at the FAA Human Factors (ATOP-R&D) web site: http://www.hf.faa.gov

Paul Krois
FAA (ATO-P R&D Human Factors)

CALENDAR

January 19-21, 2005 – Air Cargo Symposium, Ritz-Carlton New Orleans, New Orleans, LA
http://www.aci-na.org

January 24-28, 2005 – SAE G-10 Aerospace Behavioral Engineering Technology Committee, Sheraton Safari Hotel, Lake Buena Vista, Orlando, FL
http://forums.sae.org/access/dispatch.cgi/TEAG10_pf

January 25-27, 2005 – AE-2 Aerospace Lighting Committee Meeting, New Orleans, LA
elizd@sae.org

January 28, 2005 – Deadline for papers - 6th USA/Europe ATM Seminar, Baltimore, MD, June 2005 http://atmseminar.eurocontrol.fr/

February 1-3, 2005 - ATC Maastricht (EUROCONTROL), Maastricht, Netherlands http://www.atcmaastricht.com/

February 9-11, 2005 – 6th Annual Aviation Security Summit Expo, US Grant Hotel, San Diego, CA http://www.worldrg.com/AW500/wrg.asp

February 16-17, 2005 – World Aerospace Symposium, Pierre Baudis Toulouse Congress Center, Toulouse, France http://www.aviationweek.com/conferences/meu_e3.htm

March 6-8, 2005 – Air Cargo 2005, Hotel del Coronado, San Diego, CA http://www.aircargoconference.com

March 14-16, 2005 – Centers of Excellence 4th Annual Joint Meeting, Radisson Hotel, Orlando, FL

March 17-18, 2005 – Aviation and Environment Summit, Crowne Plaza, Geneva, Switzerland http://www.iata.org

March 17-18, 2005 – FAA Aviation Forecast, Washington Convention Center, Wash, DC apo.faa.gov/Conference/welcome.htm

April 2-7, 2005 – CHI 2005, Portland, OR *chi2005-chair@acm.org*.

April 5-7, 2005 – Aviation Testing Expo 2005: Scientific Conference and Technology Forum, Europe, Messe Hamburg, Germany http://www.aerospacetesting-expo.com/northamerica/conf+forum.html

April 11-15, 2005 – SAE 100th Anniversary World Congress, Cobo Hall, Detroit, MI *http://www.sae.org/congress/about/news/congressdates.htm*

April 12-13, 2005 – R,E&D Advisory Committee Meeting, Bessie Coleman Auditorium, FAA Headquarters, Wash., DC Gloria.dunderman@faa.gov

April 12-18, 2005 – Sun 'n Fun 2005, Lakeland, FL http://www.sun-n-fun.org/

April 17-22, 2005 – International Federation of Air Traffic Controller's Associations, Melbourne, Australia *http://www.ifatca.org/conferences/annual_conference.htm*

April 18-21, 2005 – 13th International Symposium on Aviation Psychology (ISAP), Cox Convention Center, Oklahoma City, OK http://www.wright.edu/isap/

April 28-29, 2005- Mini-Conference on Human Factors in Complex Sociotechnical Systems, hosted by HFES South Jersey Chapter, Atlantic City, NJ, http://www.sjhfes.org/

May 9-12, 2005 - 76th Annual Scientific Meeting of the Aerospace Medical Association, Kansas City, MO *http://www.asma.org/*

May 26-29, 2005 – American Psychological Society 17th Annual Convention, Westin Century Plaza Hotel, Los Angeles, CA http://www.psychologicalscience.org/convention/

June 2005 – 6th USA/Europe ATM Seminar, Baltimore, MD (note: call for papers deadline is January 28, 2005) http://atmseminar.eurocontrol.fr/

June 13-19, 2005 - Paris Air Show 2005, Parc des expositions de Paris Nord - Le Bourget, 93350, France. www.paris-air-show.com

June 20-22, 2005 – 3rd Human System Integration Symposium, Sheraton National Hotel, Arlington, VA http://www.navalengineers.org/Events/HSIS2005/HSIS05Index.html

July 22-28, 2005 – HCI International 2005, 11th International Conference on Human-Computer Interaction, Caesars Palace, Las Vegas, NV hcii2005@ecn.purdue.edu

July 25-31, 2005 – EAA AirVenture Oshkosh 2005, Oshkosh, WI http://www.airventure.org

August 15-18, 2005 - 43rd AIAA Aerospace Sciences Meeting and Exhibit, Hyatt Regency San Francisco at Embarcadero Center, San Francisco, CA http://www.aiaa.org/

August 18-21, 2005 - 113th Convention of the American Psychological Association, Wash, DC http://www.apa.org/convention

September 12-16, 2005 – Interact 2005, Tenth IFIP TC13 International Conference on Human-Computer Interaction, Rome, Italy http://www.interact2005.org/

September 19-23, 2005 – ANA 2005 Aviation Conference and Exhibition, Connecticut Convention Center, Hartford. CN *http://www.aerospace-na.com/ace2005.asp*

September 20-21, 2005 - R,E&D Advisory Committee Meeting (joint meeting with NASA's Aerospace Research Advisory Committee), Bessie Coleman Auditorium, FAA Headquarters, Wash., DC Gloria.dunderman@faa.gov

September 25-28, 2005 - 11th Ka and Broadband Communications Conference and 23rd AIAA International Communications Satellite Systems Conference 2005 (organized by IIC), Aurelia Convention Center, Rome, Italy http://www.aiaa.org/

September 26-28, 2005 - AIAA 5th Aviation, Technology, Integration, and Operations Forum (ATIO), Hyatt Regency Crystal City, Arlington, VA http://www.aiaa.org/

September 26-28, 2005 - AIAA 2nd Intelligent Systems Conference (IS), Hyatt Regency Crystal City, Arlington, VA http://www.aiaa.org/

September 26-30, 2005 – Human Factors and Ergonomics Society 49th Annual Meeting, Royal Pacific Resort at Universal Orlando, Orlando, FL *http://hfes.org/meetings/menu.html*

October 3-6, 2005 – SAE 2005 AeroTech Congress and Exhibition, Gaylord Texan Resort and Convention Center, Dallas/Fort Worth Airport Area, Texas
http://www.sae.org/events/conferences/aerospace/

October 6-9, 2005 – Aviation North Expo Conference, Fairbanks Princess Riverside Lodge, Fairbanks, AK *www.AviationNorth.org*

October 24-25, 2005 – National Academies Institute of Medicine Annual Meeting, National Academy of Sciences, Washington, *DC http://wwwsearch.nationalacademies.org/*

October 30—November 3, 2005 – 24th Digital Avionics Systems Conference, Hyatt Regency Crystal City, Wash., DC http://www.dasconline.org

November 6-9, 2005 - ACI World / Pacific Conference and Exhibition, Auckland, New Zealand. www.auckland-airport.co.nz

November 8-10, 2005 – Aerospace Testing Expo, North America: Scientific Conference and Technology Forum, Long Beach Convention Center, Long Beach, CA
http://www.aerospacetesting-expo.com/northamerica/conf+forum.html

January 9-12, 2006 - 44th AIAA Aerospace Sciences Meeting and Exhibit, Reno Hilton, Reno, NV http://www.aiaa.org/

January 22-26, 2006 – TRB 85th Annual Meeting, Washington, DC http://trb.org/calendar/

Note: Calendar events in Italics are new since the last Newsletter

Comments or questions regarding this newsletter?
Please contact Bill Berger at (334) 271-2928
or via e-mail at bill.ctr.berger @faa.gov

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