

DTFA01-93-Z-02054
Modification No. 0008
Interagency Agreement
Between
Department of Transportation
Federal Aviation Administration and
Naval Air Warfare Center Training Systems Division
(NAWCTSD)

The purpose of this modification is to revise the Statement of Work (SOW), revise articles on Delivery Items and Reports and Delivery Schedule, extend the period of performance, and to provide funds of \$381,703 to continue research outlined in the revised SOW under subject Interagency Agreement.

Accordingly,

1. Article III, Statement of Work, is deleted in its entirety and replaced with the following:

III. STATEMENT OF WORK

One of the issues identified by many studies is related to a lack of pilot understanding of automation. This has implications in the means used to train pilots to use flight deck automation most effectively. In one study, an extensive review of current airline and aircraft manufacturer training programs for automated aircraft showed that no training organization currently has a clear definition of skills associated with automation use that must be present when pilots enter training, or which must be demonstrated upon completion of training. The quality of understanding of training objectives, including those skills which must be performed to demonstrate proficiency in the training areas, is the cornerstone of effective training program development and assessment of automation skill proficiency. As a result, airlines that train their pilots for flying automated aircraft cannot take advantage of currently available information upon which to base their training development. This has the potential to result in training that may not be as effective as it could be if such guidance was available.

The most direct way to gain an understanding of the skills required to use flight deck automation would be to observe and record real pilots using the automation while the pilots are flying the aircraft during actual everyday flights. However, this may not be the most effective method because of the variety of approaches employed by pilots who use the automation and the lack of structure in requirements for the use of automation that pilots encounter. A more effective means to get at this information in a structured manner is to observe and record pilot use of automation in specifically designed scenarios that are flown in full-fidelity, full-flight aircraft simulators.

Unfortunately, current simulation-based methods of pilot skill assessment often require a heavy workload of the training instructor because the instructor must observe everything

that the pilot/crew is doing as well as run the simulator and facilitate the scenarios. This makes it particularly difficult to monitor the pilot's interaction with the automation because this behavior often happens quickly and can be difficult to observe. When accomplished effectively, most of these observations are subjective judgements of the instructor. For these reasons, it would benefit the aviation industry to develop methods to identify and assess pilot automation skills using simulator-generated digital data and data capture systems. These data can then be analyzed in detail to fully understand the factors that influence pilot use of automation and the skills associated with their effective use of automation. Thus, research is necessary to investigate how to best use simulation data to support the identification and assessment of automation skills. In addition to defining the critical skills required by an aviator for successful performance in automated cockpits, the second critical research question is how to elicit and measure automation skills. Toward this end, it is paramount to develop flight simulation scenarios that present situations in which automation skills are needed for successful performance. Furthermore, tools are needed to detect and measure the degree to which flight crews possess and apply the critical automation skills.

Another training area of importance to the FAA is consideration of human factors requirements in the acquisition process. Analysis has shown that the employees that have the best opportunity to consider human factors in the acquisition process often receive little training in this important area. The FAA requires development and delivery of a course, which will impart human factors principles to FAA employees.

NAWCTSD has previously been involved in the investigation of complex skill identification and assessment across a variety of aviation environments where simulation data was used to support training for tasks requiring automation. Examples include FAA projects, Multi-Service Distributed Training Testbed, Distributed Mission Training, Fleet Integration Training to Enhance Readiness, and Multi-Service Tactical Aviation Training Testbed. These research projects have been conducted in both laboratory and operational settings. Also, NAWCTSD has previously conducted a human factors awareness course for FAA employees.

The FAA wishes to take advantage of the knowledge and expertise at NAWCTSD to better understand how simulation can be used to support the identification and assessment of critical competencies required for effective performance in commercial aviation. The FAA also wishes to take advantage of the knowledge and expertise of NAWCTSD in developing and presenting a human factors awareness course. Therefore, the FAA and NAWCTSD through this Interagency Agreement, agree to pursue a joint human factors R&D program directed toward the use of simulation to identify and assess automation competencies toward the development of training strategies, methods, and tools to enhance automation skill performance. In addition, the parties also agree to a joint effort directed toward developing and presenting a human factors course for FAA employees. The joint FAA/NAWCTSD research program involves Navy and FAA personnel. Participation of FAA personnel may vary from technical monitoring of progress to active participation in various research programs.

The overall research plan is organized into four research programs. The first two research programs focus on developing strategies, methods, and tools to identify and assess flight crew automation skills. These will be programs of applied research to identify and assess flight crew automation skills. The use of full-flight simulation is valuable because it presents the best opportunity to systematically observe pilot performance that estimates actual operations, and simulators are capable of being coupled with systems that allow the digital capturing of hundreds of aircraft and pilot performance variables. This approach to identifying automation skills will provide a research environment to develop and refine the definitions and measurement methods of pilot automation skills in a systematic and structured manner resulting in a list of skills and performance measurement methods useful to the airlines for training development. The third program is an effort to measure and evaluate aircrew skills for automated aircraft. The measurement effort will focus on cognitive processes necessary for effective performance in automated aircraft. The fourth research program focuses on developing and presenting a human factors course to FAA employees.

The first research thrust focuses on identifying the capabilities of full flight simulation to support the identification of flight deck automation skills via digital pilot and aircraft performance data. The second research thrust involves investigating the use of data obtained from a full-flight simulator to measure pilot automation skill proficiency. The third research thrust is an effort to measure and evaluate aircrew skills for automated aircraft. The measurement will focus on those cognitive processes necessary for effective performance in automated aircraft. An important component of the performance measurement strategy is the development and assembly of automation-oriented events and event sets that can be introduced into scenarios to elicit those behaviors associated with automation skills. Specifically, the automated generation of scenario-based performance measures for automation skills will be investigated. The fourth research thrust involves the consideration of human factors requirements in the acquisition process. A failure to consider critical human factors needs may have drastic negative consequences to the expense and utility of any acquisition. Yet, the employees that have the best opportunity to consider human factors issues in the acquisition cycle often receive little training in this important area. The FAA requires development and delivery or a course designed to impart important human factors principles to FAA employees. NAWCTSD has a long history of developing effective training programs, with a vast amount of expertise in assessment, evaluation, curriculum development, and delivery. The FAA wishes to take advantage of this knowledge and expertise for development and delivery of this important human factors course.

The following section describes the research to be conducted in 1999.

Task 1: During the first year of this program, a research approach and methodology will be developed for using the simulator to identify and assess automation skills using simulator-based data.

1. Develop approach to use for identifying and assessing automation skills using simulator data.

- a. Conduct review of simulator use and pilot automation skills and assessment literature.
- b. Summarize pertinent simulator use and automation skills and assessment research literature.
- c. Review current simulator data collection technologies.
- d. Identify automation skills and assessment characteristics that may be identified with simulator data
- e. Establish criteria for selection of simulator-based data collection technology based on previous tasks
- f. Define the functional and technical requirements for data collection technology to support the skill identification and assessment research.
- g. Develop a research plan for identifying skills and conducting assessments with simulator data.

Task 2: Develop methodology for simulator-based data collection to identify and assess automation skills

- a. Define objectives for data collection.
- b. Define and design the tasks to be included in data collection.
- c. Review guidelines to support scenario development.
- d. Develop event-based scenarios to be used in data collection.
- e. Develop candidate simulator data measures to identify and assess skills.
- f. Define simulator requirements for data collection.
- g. Develop framework for comparing effectiveness of candidate simulator data-based skill identification and assessment methods.
- h. Review automated data reduction and analysis packages for simulator data.
- i. Identify organizations with simulator resources capable of providing candidate simulator data measures for analysis.
- j. Coordinate with organizations for potential data collection efforts.
- k. Define data documentation and archival requirements.
- l. Establish data reduction and analysis plan.

Task 3: Conduct research related to the development of an aircrew automation competency performance measure and to the development of psychometrically sound automation-oriented scenario event sets

- a. Identify critical requirements for measuring team performance in automated aircraft (review relevant automation and team performance measurement literature; collect, review, and observe aircrew team scenarios focusing on automation training; interview check airmen regarding team performance measurement requirements)
- b. Develop a measurement tool for the assessment of aircrew performance in automated aircraft (develop measurement tool to assess aircrew team performance with automated aircraft systems; identify existing or develop new scenarios and automation-oriented scenario events for assessing aircrew team performance in automated aircraft)

- c. Develop a research plan for conducting investigations on the psychometric properties of the performance measurement tool (derive a specific research plan for conducting automation investigations on the measurement tool consistent with the overall program research plan; identify functional and operational requirements for test-bed for performance measurement tool psychometric studies; submit detailed research plan for approval)
- d. Collect and store data related to the psychometric properties of the event sets required for an aircrew automation competency performance measurement tool (develop data collection and input methodology; develop data base)
- e. Determine psychometric characteristics of the tool for measuring aircrew automation competency performance (determine reliability or aircrew automation competency performance assessment tool; determine validity of aircrew automation competency performance measurement tool; determine utility of aircrew team performance measurement tool)
- f. Prepare technical report documenting the procedure employed to conduct investigations on the aircrew performance measurement tool and results of these investigations.

Task 4: Research, development and delivery of an introductory course in human factors for FAA personnel. Areas of consideration are: displays, controls, job design, anthropometrics and personnel characteristics, human-computer interfaces, physical and mental workload, principles of human cognition, usability of devices and systems, usability evaluation, and team performance. The course will include a reference to FAA Order 9550.8, Human Factors Policy.

2. IV. DELIVERABLE ITEMS AND REPORTS is deleted in its entirety and replaced with the following:

IV. DELIVERABLE ITEMS AND REPORTS

A milestone/schedule plan shall be prepared for each research program and for each task within a research program. Each task plan shall include a schedule of deliverables. A milestone/schedule plan shall be forwarded to the FAA's Contracting Officer Technical Representative (COTR) and to the FAA's Contracting Specialist within 30 days of approval of this document. Once the COTR approves the plan, a similar plan for each task will be forwarded to the COTR within 30 days. The COTR shall then establish a schedule for delivery of all remaining milestone/schedule plans. A progress review will be delivered six months after this document is approved and every six months thereafter. A monthly progress report will be prepared two months after this document is approved and on a monthly basis thereafter. An annual progress review will be prepared one year after execution of this document. The human factors course shall be delivered based on a schedule developed by the COTR.

Task 1 and Task 2

1. Literature review which describes the following: critical characteristics required for identifying and assessing automation skills using simulator data; automation skills and assessment characteristics that may be identified using simulator data.
2. Data collection methodology to be used for collecting simulator data to identify and assess automation skills, the simulator requirements for data collection, a description of the scenarios used during data collection, the simulator data measures, and the criteria used to select skills and assessment methods
3. Detailed research plan to conduct simulator-based research to identify and assess automation skills
4. Monthly status reports.
5. Final report documenting the overall effort.

Task 3

1. Comprehensive review of the aircrew team performance literature and a list of critical requirements for aircrew team performance measurement
2. A tool for measuring aircrew team performance and scenarios for data collection efforts associated with the tool
3. A research plan for conducting studies on the aircrew automation competency performance measurement tool. The research plan will include: specific hypotheses to be tested, experimental designs to be used, procedures to be employed, strategies for data analysis, and requirements for a research test bed
4. A description of the tool for measuring aircrew automation competency performance
5. Results of the data analysis including information on the reliability, validity, and utility of the aircrew automation competency performance measure
6. A technical report describing the tasks and activities performed

Task 4

1. Courseware (audiovisuals, exercise sheets), participant handouts, feedback forms.
 2. Conduct workshop in Washington DC and at the William J. Hughes Technical Center
 - 3 Research in participant responses and feedback to allow determination of course acceptance among FAA personnel from a wide variety of backgrounds
3. The DELIVERY schedule is deleted in its entirety and replaced with the following:

V. DELIVERY SCHEDULE

A. Draft Research Program Plan	30 days after award
B. Monthly Progress Reports	2 mos after award and on a monthly basis thereafter
C. Semi-annual Progress Review	6 mos after award and every six mos thereafter

- D. Annual Progress Review and final report 1 year after award and every year to end of agreement
- E. Delivery of Course Dates established by COTR

4. The period of performance of this agreement is from the effective date of the contract through July 31, 2000.

5. Revise Article XII FUNDING as follows:

3a. In paragraph B, the agreement value is increased:

<u>From</u>	<u>Increased by this Modification</u>	<u>To</u>
\$2,007,000	\$381,703	\$2,388,703

6. Accounting and Appropriation Data:

01/W/188/0/G240/8AA/2596/081110	\$366,736
01/W/901/0/G630/670/256H/PP400002	\$14,967

7. Upon completion of the effort, NAWCTSD shall refund any unused portion of FAA funding.

8. The total not-to-exceed value of the agreement is \$2,388,703.

9. Authority: this Modification No.8 to Interagency Agreement DTFA01-93-Z-02054 is entered into pursuant to previously executed Memorandum of Agreement between the FAA and NAWCTSD.

10. All other terms and conditions of the referenced agreement remain unchanged and in full force and effect.

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

NAVAL AIR WARFARE CENTER
TRAINING SYSTEMS DIVISION

By: _____
Title: Contracting Officer, ASU-310
Date:

By: _____
Title: _____
Date: